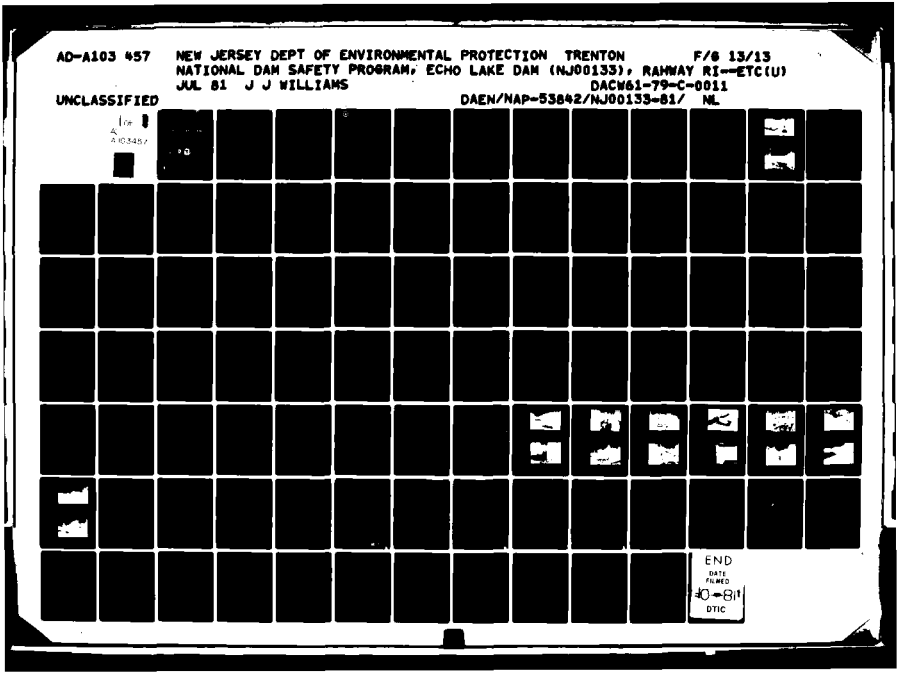
AD-A103 457 NEW JERSEY DEPT OF ENVIRONMENTAL PROTECTION TRENTON F/G 13/13
NATIONAL DAM SAFETY PROGRAM, ECHO LAKE DAM (NJ00133), RAHWAY RI--ETC(U)
JUL 81 J J WILLIAMS DACW61-79-C-0011
UNCLASSIFIED DAEN/NAP-53842/NJ00133-81/ NL



LEVEL II

AD A103457

RAHWAY RIVER BASIN
NORMA HIGGIN BROOK
UNION COUNTY
NEW JERSEY

ECHO LAKE DAM
NJ 00133

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

DTIC FILE COPY

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

JULY 1981

REPT. NO. DAEN/NAP-53842/NJ 00133 - 81/07

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

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3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): **Phase I Inspection Report National Dam Safety Program** Echo Lake Dam, NJ00133 Union County, New Jersey	5. TYPE OF REPORT & PERIOD COVERED: FINAL
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Williams, John J.	8. CONTRACT OR GRANT NUMBER(s): DACW61-79-C-0011
9. PERFORMING ORGANIZATION NAME AND ADDRESS: O"Brien & Gere Engineers Inc. Suite 1760 1617 J.F. Kennedy Blvd. Philadelphia, PA 19103	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: NJ Department of Environmental Protection Division of Water Resources P.O. Box CN029 Trenton, NJ 08625	12. REPORT DATE: July, 1981
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16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STA

National Dam Safety Program. Echo Lake Dam (NJ00133), Rahway River Basin, Norma Higgin Brook, Union County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams
Embankments
Visual Inspection
Structural Analysis
National Dam Safety Program
Echo Lake Dam, N.J.
Spillways

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-N

11 AUG 1981

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Echo Lake Dam in Union County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Echo Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 27 percent of the Spillway Design Flood (SDF) would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within three months from the date of approval of this report the owner should engage a qualified professional consultant to perform detailed stability analyses to assess the stability of the structure and determine the need and the type of mitigating measures necessary to provide for a stable structure.

c. Within three months from the date of approval of this report the access well to the reservoir drain should be cleared of debris and the surface opening secured. The operational condition of the valve should be assessed.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

NAPEN-N
Honorable Brendan T. Byrne

e. An emergency action plan and warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of appoval of this report.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Rinaldo of the Twelfth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Inspection Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

1 Incl
As stated

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Regulation
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

ECHO LAKE DAM (NJ00133)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 24 April and 3 June 1981 by O'Brien & Gere Engineers, Inc., under contract to the U.S. Army Engineer District, Philadelphia, in accordance with the National Dam Inspection Act, Public Law 92-367.

Echo Lake Dam, initially listed as a high hazard potential structure, but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in good overall condition. The dam's spillway is considered inadequate because a flow equivalent to 27 percent of the Spillway Design Flood (SDF) would cause the dam to be overtopped. To ensure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Within three months of the consultant's findings remedial measures to ensure spillway adequacy should be initiated.

b. Within three months from the date of approval of this report the owner should engage a qualified professional consultant to perform detailed stability analyses to assess the stability of the structure and determine the need and the type of mitigating measures necessary to provide for a stable structure.

c. Within three months from the date of approval of this report the access well to the reservoir drain should be cleared of debris and the surface opening secured. The operational condition of the valve should be assessed.

d. The owner should develop written operating procedures and a periodic maintenance plan to ensure the safety of the dam, within one year from the date of approval of this report.

e. An emergency action plan and warning system should be developed which outlines actions to be taken by the owner to minimize the downstream effects of an emergency at the dam within six months from the date of appoval of this report.

APPROVED: Roger Baldwin

ROGER L. BALDWIN
Lieutenant Colonel, Corps of Engineers
Commander and District Engineer

DATE: 11 Aug 81

DELAWARE RIVER BASIN

Name of Dam: Echo Lake Dam
County and State: Union County, New Jersey
Inventory Number: 00133

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by:

O'BRIEN & GERE ENGINEERS, INC.

For:

DEPARTMENT OF THE ARMY
Philadelphia District, Corps of Engineers
Custom House-2nd & Chestnut Streets
Philadelphia, PA 19106

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and anlayses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data availabe to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM INVENTORY PROGRAM

Name of Dam:	Echo Lake Dam ID # NJ 00133
State Located:	New Jersey
County Located:	Union
Stream:	Norma Higgin Brook
Coordinates:	Latitude N40°40.7', Longitude W74°20.1'
Dates of Inspection:	April 24 and June 3, 1981

ASSESSMENT

Echo Lake Dam is a concrete gravity structure about 130 feet long and 20 feet high. The surface area of the impoundment at normal pool is approximately 11 acres while storage capacity at maximum stage is estimated to be 69 acre-feet. Based on visual observations made during the field investigations, the structure appears to be in good condition.

Echo Lake Dam is classified as a "Small" size structure (height less than 40 feet, storage at maximum pool less than 1,000 acre-feet). The hazard potential for this dam is judged to be "Significant". The Spillway Design Flood (SDF) selected for this dam is fifty percent of the Probable Maximum Flood (PMF). A review of the hydrologic/hydraulic analyses indicates that the spillway is capable of passing about 13 percent of the PMF prior to overtopping the abutments. The Spillway is classified as "Inadequate".

Stability analyses were performed for the spillway sections of the dam. A review of these analyses indicates that the dam does not meet structural stability requirements with regard to resultant location as outlined in the Department of the Army publication Recommended Guidelines for Safety Inspection of Dams.

The Owner should retain the services of a licensed professional engineer experienced in the design and construction of dams to assist in complying with the following recommendations and remedial measures.

The recommendations and remedial measures which should be initiated very soon are as follows:

a. Facilities

1. Detailed hydrologic and hydraulic analyses should be performed to determine the need and type of mitigating measures necessary to provide adequate spillway capacity.

2. Detailed stability analyses should be performed to assess the stability of the structure and determine the need and the type of mitigating measures necessary to provide for a stable structure.

3. The access well to the reservoir drain valve should be cleared of debris and the surface opening secured. The operational condition of the valve should be assessed.

b. Operation and Maintenance Procedures

1. A regular maintenance program should be developed and implemented.

2. An emergency action plan should be developed which outlines actions to be taken by the Owner to minimize the downstream effects of an emergency.

O'BRIEN & GERE ENGINEERS, INC.

John J. Williams, P.E.
Vice President
New Jersey Registration No. 24916

Date: 29 July 1981

OVERVIEW OF ECHO LAKE DAM FROM THE RIGHT ABUTMENT. (4/24/81)

UPSTREAM OVERVIEW OF ECHO LAKE DAM FROM THE LEFT ABUTMENT. (4/24/81)

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
ECHO LAKE DAM
INVENTORY NUMBER NJ 00133

SECTION 1

PROJECT INFORMATION

1.1 General

a. Authority. This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with contract # DACW 61-80-D-0013 between O'Brien & Gere Engineers, Inc. and the United States Army Corps of Engineers, Philadelphia District.

b. Purpose of Inpsection. The purpose of this inspection is to evaluate the structural and hydraulic condition of Echo Lake Dam and appurtenant structures and to determine if the dam constitutes a hazard to human life or property.

1.2 Project Description (Based on information provided by the New Jersey Department of Environmental Protection (NJDEP), Union County Park Commission (UCPC) and supplemented by field observations).

a. Description of Dam and Appurtenances. Echo Lake Dam is a concrete gravity overflow structure approximately 20 feet high and 130 feet long. The structure ties in at both abutments with concrete retaining walls. All exposed faces of the structure and retaining walls have been faced with cobble size stones set into the concrete.

An ornamental waterwheel is located near the left abutment. A diversion channel is constructed from the impoundment about 20 feet upstream of the dam to the waterwheel. A control gate is located at the end of the diversion channel immediately upstream of the waterwheel. The outlet channel downstream of the waterwheel, which is about 80 feet long, discharges into the pool downstream of the dam.

A reservoir drain structure is constructed in the right sidewall and abutment. The intake which extends into the impoundment is submerged. The 24-inch diameter ductile iron outlet pipe protrudes from the right side retaining wall about 7 feet downstream of the dam. Access to the control valve is by means of a vertical well, six inches in diameter located in the top of the right side retaining wall. The valve is operated by a long handled wrench which is stored by park personnel.

The spillway discharges into a pool which is formed by a small dam (about five feet high and 32 feet long) located about 100 feet downstream of the Echo Lake Dam. A small island is located in the center of the pool. A concrete cut-off wall, three feet deep by one foot wide is constructed about 35 feet downstream of Echo Lake Dam. The area between the dam and the cut-off wall is filled with riprap.

Flows from the small lower dam discharge onto an apron surfaced with riprap. A concrete cutoff wall about three feet deep by one foot wide is located at the downstream end of the 10-foot long apron.

b. Location. Echo Lake Dam is located in Union County, New Jersey in the Borough of Mountainside on Norma Higgin Brook. The dam site is shown in the USGS Quadrangle entitled "Roselle, New Jersey" at coordinates N 40° 40.7', W 74° 20.1'. A regional location map for Echo Lake Dam is enclosed as Figure 1, Appendix E.

c. Size Classification. Echo Lake Dam has a maxiumum height of approximately 20 feet and a maximum storage capacity of 69 acre-feet. Accordingly, it is classified as a "Small" size dam (height less than 40 feet, storage less than 1,000 acre-feet).

d. Hazard Classification. A restaurant is located about 200 feet left of Norma Higgin Brook an estimated 1,300 feet downstream of the dam. The floor elevation of this structure is about eight feet above the streambed. The retail store for a nursery is located about 300 feet right of Norma Higgin Brook an estimated 1,300 feet downstream of the dam. The floor elevation of the structure is about 9 feet above the streambed. Failure of the dam could possibly cause loss of life and appreciable damage in this area. Therefore, the dam is classified in the "Significant" hazard potential category.

e. Ownership. The dam is owned by the Union County Park Commission, Union County, New Jersey. Records are maintained by Union County, New Jersey, Department of Engineering and Planning.

f. Purpose of Dam. The dam was constructed to provide a lake for recreation.

g. Design and Construction History. Based on a review of information provided by the New Jersey Department of Environmental Protection (NJDEP), the original dam at the site was completely washed out as a result of an intense rainfall and subsequent flooding in July, 1938. The spillway for this structure was reported to have been about 60 feet long with one foot of freeboard.

The dam was replaced in 1939 in conjunction with the Public Works Administration effort. A construction drawing entitled "Echo Lake Park" dated November, 1938 was provided by the Owner and is reproduced in Appendix E as Figure 4. The spillway for this structure was 70 feet long with 2.8 feet of freeboard. This dam failed in August, 1973, as a result of intense rainfall and subsequent flooding.

The structure was reconstructed in 1975. A set of design drawings (two sheets) entitled "Walls at Lower Dam Across Norma Higgin Brook, Echo Lake Park", dated June 6, 1974 and January 9, 1975, were provided by the Owner. Both drawings are reproduced in Appendix E as Figures 2 and 3. The spillway was reconstructed to a length of 130 feet with approximately 2.8 feet of freeboard.

The configuration of the reconstructed dam is that of a retaining wall. No calculations relative to structural stability were provided. A review of boring logs indicates that the base of the dam may be founded on material which might be susceptible to piping and underdrainage.

h. Normal Operating Procedures. According to the Owner's representative, no restraint to flow over the spillway exists. The gate at the end of the sealed off diversion channel is in the closed position and is no longer used. The reservoir drain has not been operated since 1975.

1.3 Pertinent Data.

a.	Drainage Area. (Square Miles)	2.5
b.	Discharge at Dam Site. (CFS)	
	Elevation 94.6 (low point, top of abutments)	1,280
c.	Elevations. (Feet above NGVD)	
	Spillway Crest 18 foot length	92.6
	86 foot length	92.7
	26 foot length	92.8
	Low Point Top of Abutments	94.6
	Reservoir Drain Invert	82.0
	Streambed at Toe of Dam	80.0
	Tailwater	±81.0
	Base of Structure	±73.0
	Diversion Channel to Waterwheel	±90.0
d.	Reservoir Length. (Feet)	
	Normal Pool Elevation 92.6	2,700
	Low Point Top of Abutments Elevation 94.6	2,900
e.	Reservoir Storage.	
	Normal Pool, Elevation 92.6	45
	Low Point Top of Abutment, Elevation 94.6	69
f.	Reservoir Surface Area. (Acres)	
	Normal Pool, Elevation 92.6	10.7
	Low Point Top of Abutment, Elevation 94.6	13.5
g.	Dam.	
	Type	Concrete Gravity Overflow
	Length	±130 feet
	Height (above foundation)	±20 feet
	Crest Width	7 inches

Slopes	Refer to sheets 2 and 3, Appendix E
Zoning	N/A
Impervious Core	N/A
Cut off	None
Grout Curtain	None

h. Diversion and Regulating Structure.

The diversion channel to the ornamental waterwheel is four feet wide and 12 feet long. The channel, which has an invert of approximately Elevation 90, is presently sealed off immediately upstream of the waterwheel.

i. Reservoir Drain.

The reservoir drain is a 24-inch diameter ductile iron pipe. The intake structure is submerged. The outlet protrudes from the right side retaining wall seven feet downstream of the dam. Access to the control valve is by means of a six-inch diameter vertical well. The top of the well is set in the crest of the retaining wall immediately above the pipe outlet.

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. The engineering data provided includes the following:

1. Construction drawing entitled "Echo Lake Park" dated November 12, 1938. (Reproduced in Appendix E, Sheet 4.)

2. Construction drawings entitled "Walls at Lower Dam across Norma Higgin Brook, Echo Lake Dam Park" drawings numbered 24 and 25 of 25 (Reproduced in Appendix E, Sheets 2 and 3).

3. Hydraulic calculations prepared by Frank H. Lehr Associates.

b. Design Features. The principal design features for this structure are discussed in Section 1.2.a and shown on the drawings enclosed in Appendix E.

2.2 Construction.

No progress reports relative to the construction of the dam nor "as built" drawings were provided for review.

2.3 Operation.

According to the Owner's representative, Mr. Michael J. Cerra, Chief Engineer/Parks, no operational features are associated with this structure. The reservoir drain valve has not been operated since the time of reconstruction of the dam in 1975.

2.4 Evaluation.

a. Availability. The engineering data utilized in this report was provided by the Owner, Union County Park Commission (UCPC) and the New Jersey Department of Environmental Protection (NJDEP).

b. Adequacy. Based on the information provided by the NJDEP, the Owner and observations made during the field inspection, adequate information is available for a Phase I evaluation.

c. Validity. There is no reason to question the validity of the data provided.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. Echo Lake Dam was inspected on April 24 and June 3, 1981. At the time of the inspections, the water surface elevation was less than 0.1 feet above the spillway crest. The observations and comments of the field inspection team are presented in Appendix B of this report. Elements of the structure which are under water were not inspected. The overall appearance of the dam is good.

b. Dam. The horizontal and vertical alignment of the dam appeared to be consistent with the construction drawings provided by the Owner. No settlement or displacement was evident. Water was discharging over 18 feet of the spillway length of from 26 to 44 feet from the left side retaining wall. The upstream face of the dam could not be observed because it was submerged. Some debris was evident along the spillway crest. The debris was essentially limited to leaves and brush.

No evidence of seepage was noted on the downstream face of the dam or at the dam and abutment junctions. The joints in all the stone masonry elements of the structure appear to be intact. No structural cracking was noted.

c. Appurtenant Structures.

The abutments of the dam are stabilized by retaining walls similar in appearance to the dam. The retaining walls extend upstream and downstream of the dam and appear to be in general conformance with the construction drawing provided by the Owner and reproduced in Appendix E, Sheets 2 and 3. The walls vary in height with the maximum wall height being about 15 feet above the water surface immediately downstream of the dam. No deflection or settlement in the walls was noted. Weepholes are located in the bottom half of the walls downstream of the dam. No flow was noted in the weepholes.

Most of the reservoir drain structure is not visible; however, no discharge was observed at the outlet. The Owner was unable to open the drain valve at the time of the inspection because the access well was filled with debris. According to the Owner's representative, the valve is not exercised regularly and has not been activated since completion of the reconstruction in 1975.

d. Reservoir Area.

The reservoir side slopes vary from a few percent up to a maximum of about 2H:1V. The perimeter grounds are well maintained in a grass and natural vegetative cover.

e. Downstream Channel.

The spillway discharges into a lower pool (lagoon) which is formed by a five-foot high by 32-foot long dam about 100 feet downstream from Echo Lake Dam. No settlement or displacement was noted in the aprons of either dam or in the lower dam. The channel downstream of both dams averages about 20 feet in width with about 4-foot high banks and side slopes approximating 1H:1V. Very little debris or obstructions were observed in the downstream channel.

SECTION 4

OPERATIONAL FEATURES

4.1 Procedures.

Based on a conversation with the Owner's representative, no formal operating procedures are established for Echo Lake Dam.

4.2 Maintenance of Dam

According to the Owner's representative, maintenance is performed on an "as required" basis.

4.3 Maintenance of Operating Facilities.

Based on a review of drawings provided by the Owner, the diversion channel to the ornamental waterwheel is sealed off immediately upstream of the waterwheel.

Based on a conversation with the Owner's representative, the reservoir drain is an operating part of the dam. Based on all information available, the drain was last utilized when the dam was reconstructed in 1975. An attempt was made by the Owner's representative to exercise the drain control valve during the field inspections; however, the vertical access well to the stem was clogged with debris and the effort was unsuccessful.

4.4 Description of Warning System in Effect.

According to the Owner's representative, no warning system, formal or informal, is in effect for Echo Lake Dam.

4.5 Evaluation of Operational Adequacy.

It is not known if the reservoir drain system is operational.

It appears that the dam is accessible under all weather conditions.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. Based on a review of the design data provided, the drainage area contributing to Echo Lake Dam is 2.5 square miles. The maximum length of the basin is about 2.5 miles and the maximum width is about 1.5 miles. Elevations within the basin vary from a maximum of about Elevation 480 to Elevation 92.6 at normal pool. The normal surface area of the lake is 10.7 acres and the associated storage is 45 acre feet. With the impoundment at the low point of the top of the dam Elevation 94.6, the storage capacity is 69 acre-feet and the spillway discharge capacity is 1,280 cfs. Most of the watershed is urbanized.

The spillway was designed to pass a flood flow of 1,150 cfs at a head of 1.8 feet with a freeboard of 1.0 feet. According to the material provided by the Owner's representative, the structure is designed for the one-hundred year event.

b. Experience Data. According to the Owner's representative, no records of reservoir stage or rainfall are maintained for this dam. It takes about 4 days to drawdown the reservoir. Refer to drawdown calculations to Appendix C.

c. Visual Observations. At the time of the inspection, some debris was accumulated at the spillway crest. The vertical access well to the reservoir control valve was obstructed with debris. The operational condition of the valve could not be assessed.

d. Overtopping Potential. Echo Lake Dam is classified as "Small" size, "Significant" hazard structure. Accordingly, the Spillway Design Flood (SDF) for this structure ranges from the one-hundred year flood to fifty percent of the Probable Maximum Flood (PMF). The SDF selected for use is fifty percent of the PMF.

The SDF hydrograph was developed using an SCS unit hydrograph which was routed through the reservoir with the starting water surface elevation at the spillway crest (Elevation 92.6). The peak inflow and outflow rates for the SDF were computed to be about 6,760 and 6,480 cfs, respectively. The maximum reservoir stage for this event is 3.1 feet above the low point of the top of the abutment and the duration of overtopping is about 5.2 hours. The spillway is capable of discharging approximately 13 percent of the PMF prior to overtopping the embankment (refer to Appendix C for computations and printout).

e. Spillway Adequacy. The spillway is considered "Inadequate" since it is not capable of discharging the SDF.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations. The overall appearance of the dam at the time of the inspection was good. The horizontal and vertical alignment of the dam appeared to be consistent with the construction drawings provided by the Owner. No settlement or displacement was evident. The upstream face of the dam could not be observed because it was submerged.

No evidence of seepage was noted on the downstream face of the dam or at the dam and abutment junctions. The joints on all the masonry elements of the structure appear to be intact. No structural cracking was noted.

b. Design and Construction Data.

Sheets 2, 3 and 4 of Appendix E were provided by the Owner's representative. These drawings are the extent of the design and construction data which was provided to assist in preparation of this report.

c. Operating Records. According to the Owner's representative, no operating records are maintained for this dam.

d. Post-Construction Changes. Based on all available information, no records exist of any post-construction changes subsequent to the reconstruction of the dam in 1975.

e. Seismic Stability. Echo Lake Dam is located in Seismic Zone 1 on the Seismic Zone Map of Contiguous States. Spillway sections represented by Section A-A on Sheet 2 of Appendix E and Section C-C on Sheet 3 of Appendix E were analyzed for seismic stability with the water in the impoundment at the spillway crest Elevation 92.6 and no tailwater. Full uplift conditions varying from the impoundment elevation at the upstream end to the base of the dam at the downstream end were assumed for the analyses. The spillway sections meet the stability requirements for Zone 1 Seismic loading conditions according to the criteria outlined in the Recommended Guidelines for Safety Inspection of Dams. Refer to Appendix G for the seismic stability calculations.

f. Structural Stability. Spillway sections represented by Section A-A on Sheet 2 of Appendix E and Section C-G on Sheet 3 of Appendix E were analyzed for structural stability with the water in the impoundment at the spillway crest Elevation 92.6 and no tailwater. Full uplift conditions, varying from the impoundment elevations at the upstream end to the base of the dam at the downstream end were assumed for the analyses. The resultant of forces is located outside the middle third of the base for both sections. The criteria outlined in the Recommended Guidelines for Safety Inspection of Dams states that the resultant should be located within the middle third of the base width. Refer to Appendix G for the structural stability calculations.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment

a. Evaluation. Based on the visual inspection, Echo Lake Dam is judged to be in good condition. The access well to the reservoir drain is blocked with debris. It is not known if the valve is operational.

The selected SDF for Echo Lake Dam is fifty percent of the PMF. Based on the analyses performed for this report, the spillway is capable of passing 13 percent of the PMF prior to overtopping the abutment. The spillway is, therefore, classified as "Inadequate".

Seismic and structural stability analyses were performed for the spillway sections. Based on these analyses, the spillway sections of the dam meet the criteria for seismic stability but do not meet the requirements for structural stability according to the criteria outlined in the Recommended Guidelines for Safety Inspection of Dams.

b. Adequacy of Information. Based on the information provided by the NJDEP, the Owner and observations made during the field investigation, adequate data is available for a Phase I evaluation.

c. Urgency. The remedial measures recommended in Section 7.2 should be initiated very soon.

d. Necessity for Further Investigation. Further investigations should be performed in accordance with 7.2a, numbers 1 and 2.

7.2 Recommendations and Remedial Measures

The Owner should retain the services of a licensed professional engineer experienced in the design and construction of dams to assist in complying with the following recommendations and remedial measures.

Recommendations and remedial measures which should be initiated very soon are as follows:

a. Facilities

1. Detailed hydrologic and hydraulic analyses should be performed to determine the need and type of mitigating measures necessary to provide adequate spillway capacity.

2. Detailed stability analyses should be performed to assess the stability of the structure and determine the need and the type of mitigating measures necessary to provide for a stable structure.

3. The access well to the reservoir drain should be cleared of debris and the surface opening secured. The operational condition of the valve should be assessed.

b. Operation and Maintenance Procedures

1. A regular maintenance program should be developed and implemented.

2. An emergency action plan should be developed which outlines actions to be taken by the Owner to minimize the downstream effects of an emergency.

APPENDIX

A

Check List Engineering Data

Design, Construction, Operation

Phase I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Echo Lake Dam

ID # NJ 00133

ITEM	REMARKS
AS-BUILT DRAWINGS	Not available
REGIONAL VICINITY MAP	Refer to Appendix E, Figure 1
CONSTRUCTION HISTORY	No information available.
TYPICAL SECTIONS OF DAM	Refer to Appendix E, Figures 2 and 3
OUTLETS - PLAN	Refer to Appendix E, Figures 2 and 3
DETAILS	
CONSTRAINTS	
DISCHARGE RATINGS	None available
RAINFALL/RESERVOIR RECORDS	None available

ITEM	REMARKS
DESIGN REPORTS	None available.
GEOLOGY REPORTS	Boring logs (2 holes) were made available (Refer to Appendix F). The locations of the holes are unknown.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Limited information was made available relative to hydrology and hydraulics (Refer to section 5.1 a). No information relative to dam stability or seepage studies was made available.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Refer to Appendix F for boring logs.
POST-CONSTRUCTION SURVEYS OF DAM	None available.
BORROW SOURCES	N/A

ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	Refer to Section 1.2g.
HIGH POOL RECORDS	None available.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None available.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Refer to Section 1.2g.
MAINTENANCE OPERATION RECORDS	None available.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Refer to Appendix E, Figures 2 and 3
OPERATING EQUIPMENT PLANS & DETAILS	Refer to Appendix E, Figures 2 and 3
MISCELLANEOUS	

APPENDIX

B

Check List

Visual Inspection

Phase I

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam Echo Lake Dam County Union State New Jersey National ID # NJ 00133

Type of Dam Concrete Gravity Hazard Category Significant

Date(s) Inspection 4/24/81 (6/2/81) Weather Cloudy w/rain (4/24/81) Temperature 60 degrees (4/24/81)

Pool Elevation at Time of Inspection 92.65 ± M.S.L. Tailwater at Time of Inspection 81 ± M.S.L.

Inspection Personnel:

L.R. Beck
L.DeHeer (6/2/81)
J.F. Rauschkolb
R.E. Horvath

R.E. Horvath Recorder

Remarks:

The inspection team was accompained by Mr. Michael J. Cerra, Chief Engineer/Parks, County of Union, New Jersey, Department of Engineering and Planning. (4/24/81)

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	None observed	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	No seepage or evidence or relative movement was noted. Minor erosion was evident at the left abutment. The erosion appears to be a result of foot traffic.	
DRAINS	No drains are evident in the dam. However, weepholes were noted in the retaining walls downstream of the dam. No flow was observed coming from any of the weepholes.	
WATER PASSAGES	A diversion channel to an ornamental water wheel is sealed. Surfaces visible appear to be in good condition.	
FOUNDATION	Not observed.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	None observed.	
STRUCTURAL CRACKING	None observed.	
VERTICAL AND HORIZONTAL ALIGNMENT	No evidence of settlement or deflection was noted.	
MONOLITH JOINTS	No leakage or evidence of movement was noted.	
CONSTRUCTION JOINTS	No leakage or evidence of movement was noted.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Not observed.	
INTAKE STRUCTURE	Submerged.	
OUTLET STRUCTURE	A 24 inch diameter cast iron pipe protrudes from retaining wall (right side) about 5 feet downstream of the dam. Only the outlet end is visable.	
OUTLET CHANNEL	Reservoir drain discharges to the spillway channel.	
EMERGENCY GATE	24 inch gate valve. Access well to gate is blocked with debris.	The well should be cleared of all debris.

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Surfaces appear to be in good condition.	
APPROACH CHANNEL	Impoundment.	
DISCHARGE CHANNEL	The spillway discharge channel is lined (with riprap and stone set in concrete) for a distance of about 100 feet downstream. A small dam is constructed at this location to form a plunge pool.	
BRIDGE AND PIERS	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	N/A	
OBSERVATION WELLS	N/A	
WEIRS	N/A	
PIEZOMETERS	N/A	
OTHER	N/A	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The impoundment is in a park environment. Maximum slopes are about 2 horizontal to one vertical and appear to be well maintain with a grass cover.	
SEDIMENTATION	Not observed or assessed.	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is the natural stream. The channel is approximately 4 feet deep and 20 feet wide with 1 horizontal to 1 vertical sideslopes. Very little debris or obstructions were observed in the channel.	
SLOPES	The channel overbanks are relatively flat.	
APPROXIMATE NO. OF HOMES AND POPULATION	A restaurant is located about 1,000 feet downstream of the dam. The floor elevation of this structure is located about 8 feet above the streambed. A number of inhabited homes are also located downstream of the dam. However, the floor elevations of these homes appear to be less critical then elevation of the restaurant.	

APPENDIX

C

Hydrologic & Hydraulic Data

ECHO LAKE DAM
APPENDIX C
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

TABLE OF CONTENTS

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	1	JFR	5-4-81	1800-006

JFR 6/5/81

HYDROLOGY CALCULATIONS

Drainage Area = 12.49 sq.mi.

Upper Reservoir D.A. = 1.79 sq.mi.
Lower Reservoir (Echo Lake) D.A. = 0.70 sq.mi.

PMP DATA - HMS REPORT 33

Area is in Zone 61 of PMP ALL Season Envelope.

24 hr, 200 sq.mi. Rainfall = 22.5 in.

Storm Distribution

Hr.	%
6	113
12	124
24	132
48	142

BASIN LAG TIME - Upper Reservoir

1. SCS Upland Method:

Greatest hydraulic distance to upper reservoir consists of 5000 ft. of overland flow and 4500 ft. of stream flow.

Avg. overland slope = $\frac{\Delta El.}{d_o} = \frac{480-130}{5000} \times 100 = 7\%$

Paved area & small upland gullies, V_o = 5.3 fps (Fig 15.2, Pg 15-8, SCS NEH-4)

$t_o = \frac{5000}{5.3} = 943$ sec. = 0.26 hr.

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	2	JFR	5-7-81	1800-006

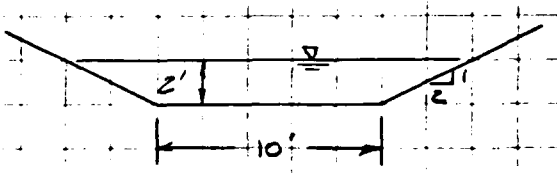
vdf. 6/5/81

Avg. stream slope = $\frac{130 - 98}{4500} = 0.007 \frac{ft.}{ft.}$

$V_s = \frac{1.49}{n} R^{2/3} S^{1/2}$

$= \frac{1.49}{.05} (1.48)^{2/3} (.007)^{1/2}$

$= 3.2$ fps



$n = .05$, $R^2 = 18.9'$

$A = 28$ ft²

$t_s = \frac{4500}{3.2} = 1406$ sec.

$= 0.39$ hrs.

$T_c = 0.26 + 0.39 = 0.65$ hr.

Lag, $L = 0.6\, T_c = .6(.65) = 0.39$ hr.

2. SCS Curve Number Method:

$L = \frac{l^{.8} (S+1)^{.7}}{1900\, Y^{.5}}$

$S = \frac{1000}{CN} - 10 = \frac{1000}{90} - 10 = 1.1$

$l = 9500$ ft.

$Y = \frac{480 - 98}{9500} \times 100 = 4\%$

$L = \frac{(9500)^{.8} (1.1 + 1)^{.7}}{1900 (4)^{.5}} = 0.68$ hr.

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	3	JFR	5-7-81	1800-006

3. California Highways Method:

$$T_c = \left(\frac{11.9\,L^3}{H}\right)^{0.385}$$

$L = 9500/5280 = 1.80$ mi.

$H = \Delta El. = 480 - 98 = 382$ ft.

$$T_c = \left(\frac{11.9\,(1.80)^3}{382}\right)^{.385} = 0.52 \text{ hrs.}$$

$L = 0.6\,(.52) = 0.31$ hrs.

4. Kerby Method:

$$T_c = \left(\frac{2}{3}\,\frac{Ln}{\sqrt{S}}\right)^{.467}$$

$L = 9500'$

$n = 0.05$

$S = 0.04$ ft/ft

$$T_c = \left(\frac{2}{3}\,\frac{(9500)(.05)}{\sqrt{.04}}\right)^{.467} = 31 \text{ min.}$$

$L = 0.6\,(31/60) = 0.31$ hrs.

→ USE SCS LAG, L = 0.39 HOUR.

(upland Method)

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	4	JFR ✓ RL	5-8-81 6/5/81	1800-006

BASIN LAG TIME - ECHO LAKE

1. SCS Upland Method:

Greatest hydraulic distance to Echo Lake consists of 3000 ft. of overland flow.

$$\text{Avg. slope} = \frac{\Delta El.}{D} = \frac{150 - 93}{3000} \times 100 = 1.9\%$$

Paved area & small upland gullies, V = 2.8 fps (Fig 15.2, pg 15-8, SCS NEH 4)

$$T_c = \frac{3000}{2.8} = 1071 \text{ sec.} = 0.30 \text{ hr.}$$

$$L = 0.6\, T_c = 0.6\,(.30) = 0.18 \text{ hr.}$$

2. SCS Curve Number Method:

$$L = \frac{l^{.8}\,(S+1)^{.7}}{1900\, Y^{.5}}$$

$$S = \frac{1000}{90} - 10 = 1.1$$

l = 3000 ft.

Y = 1.9%

$$L = \frac{(3000)^{.8}\,(2.1)^{.7}}{1900\,(1.9)^{.5}} = 0.39 \text{ hr.}$$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	5	JFK ✓ JFK	5-8-81 6/5/81	1900-006

3. California Highways Method:

$$T_c = \left(\frac{11.9\,L^3}{H}\right)^{.385}$$

$L = 3000 / 5280 = 0.57$ mi.

$H = 150 - 93 = 57$ ft.

$$T_c = \left(\frac{11.9\,(.57)^3}{57}\right)^{.385} = 0.29 \text{ hr.}$$

$L = 0.6\,T_c = 0.6\,(.25) = 10.17$ hr.

4. Kerby Method:

$$T_c = \left(\frac{2}{3}\,\frac{Ln}{\sqrt{S}}\right)^{.467}$$

$L = 3000'$

$n = .04$

$S = 0.019$ ft/ft

$$T_c = \left(\frac{2}{3}\,\frac{(3000)(.04)}{\sqrt{.019}}\right)^{.467} = 19.5 \text{ min.}$$

$L = 0.6\,T_c = 0.6\,(19.5/60) = 0.20$ hr.

→ USE SCS LAG, $L = \underline{0.18}$ hr.
(Upland Method)

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	6	JFR	5-4-81	1800-006

VF 6/5/81

AREA - ELEVATION DATA, UPPER RESERVOIR

W.S. ELEV.	AREA *
92.65 (Norm. Pool)	8.0 ac.
100	18.7 ac.
120	33.0 ac.
140	59.7 ac.

AREA - ELEVATION DATA, ECHO LAKE

W.S. ELEV.	AREA *
80.0	0
92.65 (Norm. Pool)	10.7 Ac.
100	27.3 Ac.
120	80.6 Ac.
140	684.6 Ac.

* Planimetered from USGS Quad Sheets

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam - H&H	7	REH	5/11/81	1800.006.113

V.P.J. 6/6/81

HYDRAULICS

FOR SPILLWAY AT UPPER RESERVOIR

Crest Width = 2', Freeboard = 4'
Crest Length = 160'

WSE	H(ft)	C	Q(cfs)
97.65	0	2.6	—
98.65	1	2.8	168
99.65	2	3.3	560
100.65	3	3.3	1029
101.65	4	3.3	1584
102.65	5	3.3	2214
103.65	6	3.3	2910
104.65	7	3.3	3667
105.65	8	3.3	4480

For overtopping, use 500 feet, C = 2.6

Overtopping elevation ≈ 101.65

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam - H&H	8	REH	5/11/81	1800.006.113
		VE	6/5/81	

HYDRAULICS (Cont'd)

For Echo Lake Dam - Spillway

Based on a review of available drawings, the spillway crest elevation varies from 92.65 to 92.83, approximately 2 inches. For the hydrologic/hydraulic analyses, elev. 92.65 has been used for the full spillway length

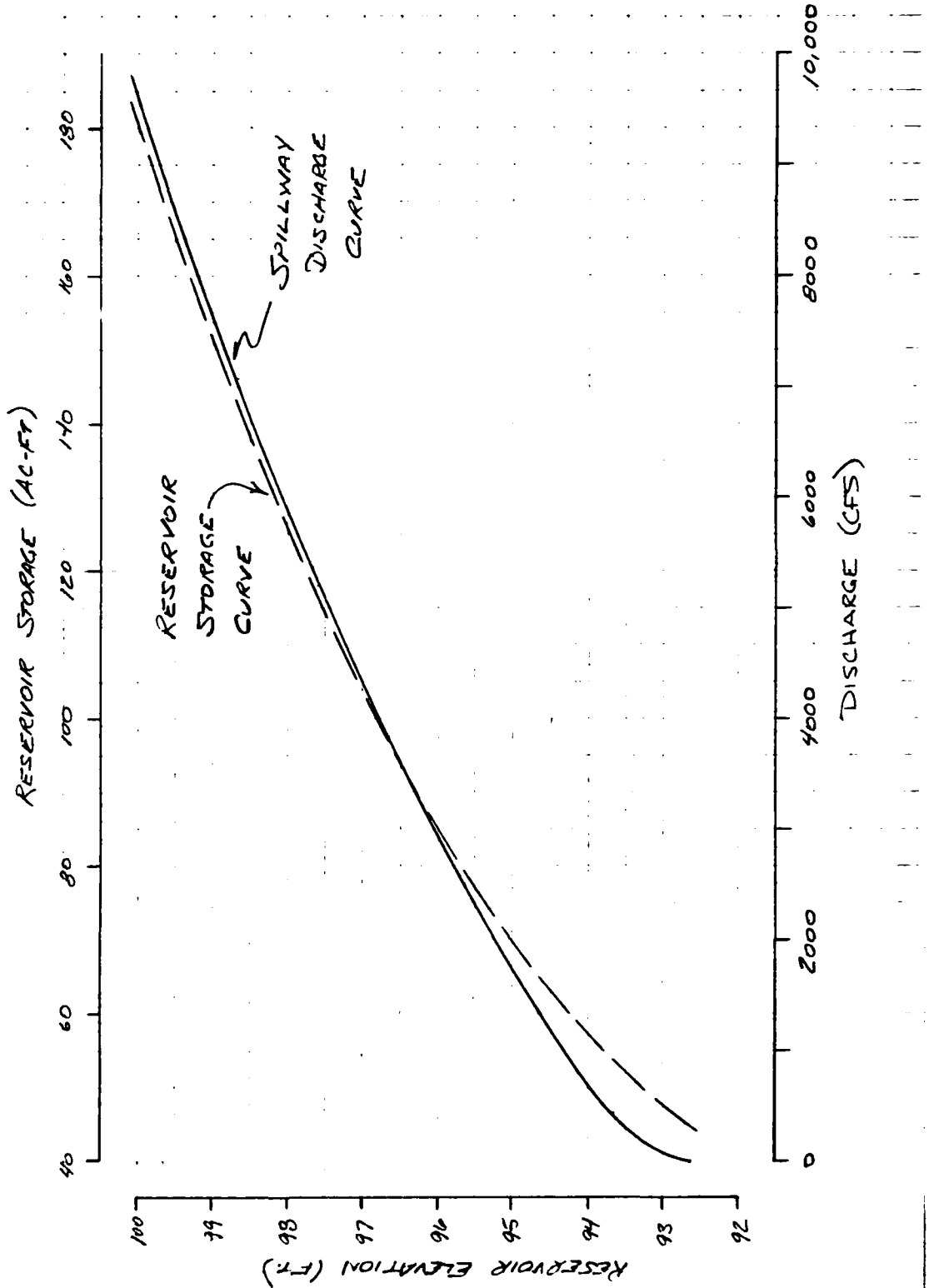
Crest Length = 130 feet
Crest elev = 92.65
Crest width = 7 inch
Coeff of Discharge C - from Hbk of Hydraulics, Table 5-11, Slope of upstream face ≈ 2H:1V

WSE	H(ft)	C	Q(cfs)
92.65	0	—	—
93.65	1	3.4	442
94.65	2	3.6	1324
95.65	3	3.7	2499
96.65	4	3.7	3848
97.65	5	3.7	5378
98.65	6	3.7	7069
99.65	7	3.7	8908
100.00	7.35	3.7	9585

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H & H	9	JFR	7-27-81	1800-006-113

STAGE DISCHARGE / STORAGE ECHO LAKE DAM

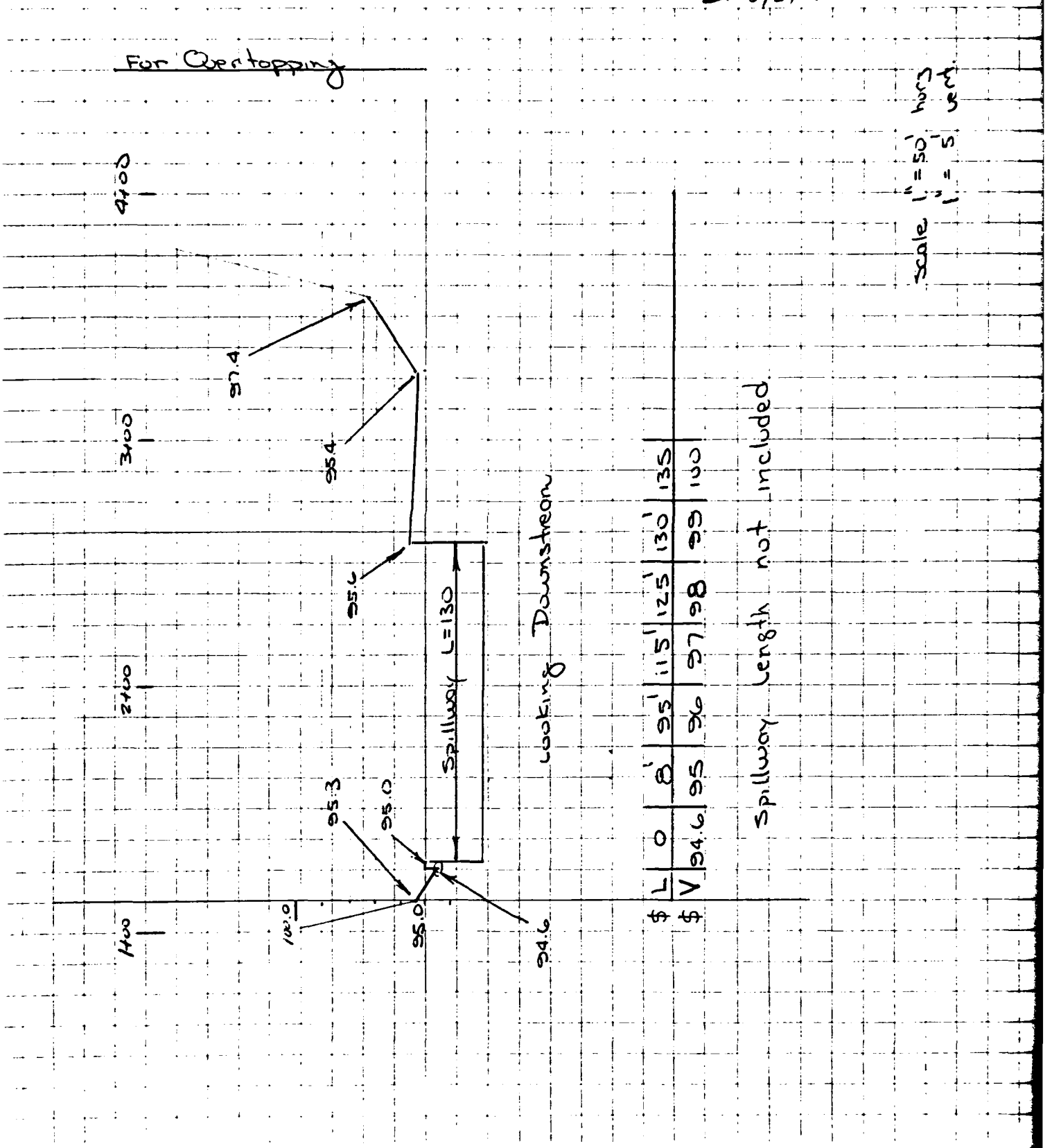


O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam - H & H	10	REH	5/11/81	1800.006.113

V.E. 6/5/81

For Overtopping



O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	11	JFR	7-28-81	1800-006-113

DRAWDOWN ANALYSIS

24-inch $\emptyset$ reservoir drain - ductile iron pipe
Length $\cong$ 54'
2 bends @ 90°
1 bend > 90°
Outlet invert @ EL. 82.0, Inlet invert @ EL. 84.0

$$Q = \sqrt{\frac{2gH}{1 + K_e + \Sigma K_b + 29n^2L/R^{1.33}}}\ A_p$$

$K_e \cong 0.5$
$\Sigma K_b \cong 0.2 + 0.2 + 0.1 = 0.5$
$n = 0.013$
$R = \frac{\pi(1)^2}{\pi(2)} = 0.50$

$$Q = \sqrt{\frac{2(32.2)H}{1 + 0.5 + 0.5 + 29(.013)^2(54)/(.5)^{1.33}}}\ \pi(12/12)^2$$

$$Q = 16.66\ H^{1/2}$$

$$\text{Volume} = 970.89\ (h_2^3 - h_1^3)\ ft^3$$ ... integration of vol. cone

$$t = \frac{\forall}{Q} \quad \text{seconds}$$

Normal Pool Elev. = 92.65

Base Flow = 1.5 cfm * 2.49 s.mi.
= 3.75 cfs (OVER)

$Q_{NET} = Q - 3.75$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM - H&H	12	JFR	7-28-81	1800-006-113

DRAWDOWN (CONT'D)

RESERVOIR ELEVATION	$\Delta \forall$ (ft^3)	H_{AVG} (ft)	Q_{NET} (cfs)	t (sec)
92.65 - 92.0	287,659	9.325	47	6120
92.0 - 91.0	385,443	8.5	45	8565
91.0 - 90.0	321,364	7.5	42	7652
90.0 - 89.0	263,111	6.5	39	6746
89.0 - 88.0	210,683	5.5	35	6020
88.0 - 87.0	164,080	4.5	32	5129
87.0 - 86.0	123,303	3.5	27	4567
* 86.0 - 85.0	88,351	2.5	17	5197
* 85.0 - 84.0	59,224	1.5	0.2	296,120

* Pipe flows partially full

@ AVG W.S.E. 85.5 , $R = 2.5274/5.9208 = 0.427$

$$Q = \left[\frac{64.4\ H}{2 + 29\,(.013)^2(54)/(.427)^{1.33}}\right]^{1/2} 2.5274 = 13.38\,H^{1/2}$$

@ AVG W.S.E. 84.5 , $R = .6142/3.8264 = 0.161$

$$Q = \left[\frac{64.4\ H}{2 + 29\,(.013)^2(54)/(.161)^{1.33}}\right]^{1/2} .6142 = 3.22\,H^{1/2}$$

Drawdown Time (to EL. 85) = $\frac{49,595}{3600}$ = 14 hours

Drawdown Time (to EL 84) = $\frac{346,115}{86,400}$ = 4 Days

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION- 01 APR 80
**********
    1  A1                          NATIONAL DAM INSPECTION PROGRAM
    2  A2                                ECHO LAKE DAM
    3  A3                                PMF HYDROGRAPH
    4  B    300       0      10       0       0       0       0       0      -4       0
    5  B1     5
    6  J      1       9       1
    7  J1    .1      .15      .2      .25      .3      .35      .4      .5     1.0
    8  K      0  LAKE-1                                                  1
    9  K1       RUNOFF HYDROGRAPH FROM UPSTREAM DRAINAGE AREA
   10  M      1       2    1.79              2.49                                1
   11  P      0    22.5     113     124      132     142
   12  T                                                          1.0     .05
   13  W2             .39
   14  X   -1.5     -.05      -2
   15  K      1  DAM-1                                                    1
   16  K1       ROUTING THROUGH UPSTREAM RESERVOIR
   17  Y                                      1       1
   18  Y1     1                                                  -97.65      -1
   19  Y4 97.65   98.65   99.65  100.65  101.65  102.65  103.65  104.65  105.65
   20  Y5     0     168     560    1029    1584    2214    2910    3667    4480
   21  $A     8    18.7      33    59.7
   22  $E 97.65     100     120     140
   23  $$ 97.65
   24  $D101.65     2.6     1.5     300
   25  K      0  LAKE-2                                                   1
   26  K1       RUNOFF HYDROGRAPH FROM ECHO LAKE DRAINAGE AREA
   27  M      1       2     .70              2.49                                1
   28  P      0    22.5     113     124      132     142
   29  T                                                          1.0     .05
   30  W2             .18
   31  X   -1.5     -.05       2
   32  K      2  LAKE-2                                                   1
   33  K1       COMBINE DISCHARGE AND INFLOW HYDROGRAPHS
   34  K      1  DAM-2                                                    1
   35  K1       ROUTING THROUGH ECHO LAKE DAM
   36  Y                                      1       1
   37  Y1     1                                                  -92.65      -1
   38  Y4 92.65   93.65   94.65   95.65   96.65   97.65   98.65   99.65     100
   39  Y5     0     442    1324    2499    3848    5378    7069    8908    9585
   40  $A     0    10.7    27.3    80.6   684.6
   41  $E    80   92.65     100     120     140
   42  $$ 92.65
   43  $D  94.6     2.6     1.5     135
   44  $L     0       8      95     115     125     130     135
   45  $V  94.6      95      96      97      98      99     100
   46  K     99
1                  PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                   RUNOFF HYDROGRAPH AT      LAKE-1
                   ROUTE HYDROGRAPH TO       DAM-1
                   RUNOFF HYDROGRAPH AT      LAKE-2
                   COMBINE  2 HYDROGRAPHS AT LAKE-2
                   ROUTE HYDROGRAPH TO       DAM-2
                   END OF NETWORK
```

Sh 13

NATIONAL DAM INSPECTION PROGRAM
ECHO LAKE DAM
PMF HYDROGRAPH

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	10	0	0	0	0	0	4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1

RTIOS= .10 .15 .20 .25 .30 .35 .40 .50 1.00

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH FROM UPSTREAM DRAINAGE AREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE 1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	1.79	0.00	2.49	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.50	113.00	124.00	132.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .39

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
0													
							SUM			25.56	23.17	2.39	164552.
										(649.)	(589.)	(61.)	(4659.59)

Sh 14

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH UPSTREAM RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM-1	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-98.	-1

STAGE	97.65	98.65	99.65	100.65	101.65	102.65	103.65	104.65	105.65
FLOW	0.00	168.00	560.00	1029.00	1584.00	2214.00	2910.00	3667.00	4480.00
SURFACE AREA=	8.	19.	33.	60.					
CAPACITY=	0.	30.	541.	1455.					
ELEVATION=	98.	100.	120.	140.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
97.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
101.7	2.6	1.5	300.

PEAK OUTFLOW IS 800. AT TIME 40.33 HOURS

PEAK OUTFLOW IS 1209. AT TIME 40.33 HOURS

PEAK OUTFLOW IS 1638. AT TIME 40.33 HOURS

PEAK OUTFLOW IS 2336. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 2965. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 3533. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 4074. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 5121. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 10500. AT TIME 40.00 HOURS

Sh 15

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH FROM ECHO LAKE DRAINAGE AREA

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE-2	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	.70	0.00	2.49	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.50	113.00	124.00	132.00	142.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .18

RECESSION DATA

STRTQ= 1.50 QRCSN= .05 RTIOR= 2.00

END-OF-PERIOD FLOW

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	25.56	23.17	2.39	65280.
										(649.)	(589.)	(61.)	(1848.52)

********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE DISCHARGE AND INFLOW HYDROGRAPHS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
LAKE-2	2	0	0	0	0	1	0	0

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING THROUGH ECHO LAKE DAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
DAM-2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	ISK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-93.	-1

Sh 16

STAGE	92.65	93.65	94.65	95.65	96.65	97.65	98.65	99.65	100.00
FLOW	0.00	442.00	1324.00	2499.00	3848.00	5378.00	7069.00	8908.00	9585.00
SURFACE AREA=	0.	11.	27.	81.	685.				
CAPACITY=	0.	45.	180.	1212.	7879.				
ELEVATION=	80.	93.	100.	120.	140.				

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
92.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
94.6	2.6	1.5	135.

CREST LENGTH AT OR BELOW ELEVATION	0.	8.	95.	115.	125.	130.	135.
	94.6	95.0	96.0	97.0	98.0	99.0	100.0

PEAK OUTFLOW IS 1011. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 1523. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 2066. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 2774. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 3586. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 4352. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 5097. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 6484. AT TIME 40.17 HOURS

PEAK OUTFLOW IS 13539. AT TIME 40.00 HOURS

********** ********** ********** ********** **********

1

SH 17

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 .10	RATIO 2 .15	RATIO 3 .20	RATIO 4 .25	RATIO 5 .30	RATIO 6 .35	RATIO 7 .40	RATIO 8 .50	RATIO 9 1.00
HYDROGRAPH AT	LAKE-1	1.79	1	1106.	1659.	2213.	2766.	3319.	3872.	4425.	5532.	11063.
		(4.64)		(31.33)(	46.99)(	62.65)(	78.32)(	93.98)(	109.64)(	125.31)(	156.64)(	313.27)
ROUTED TO	DAM-1	1.79	1	800.	1209.	1638.	2336.	2965.	3533.	4074.	5121.	10500.
		(4.64)		(22.66)(	34.24)(	46.38)(	66.14)(	83.96)(	100.05)(	115.36)(	145.01)(	297.33)
HYDROGRAPH AT	LAKE-2	.70	1	559.	838.	1118.	1397.	1677.	1956.	2236.	2795.	5589.
		(1.81)		(15.83)(	23.74)(	31.65)(	39.57)(	47.48)(	55.40)(	63.31)(	79.14)(	158.27)
2 COMBINED	LAKE-2	2.49	1	1092.	1635.	2177.	2879.	3669.	4497.	5292.	6763.	13929.
		(6.45)		(30.71)(	46.31)(	61.65)(	81.51)(	103.90)(	127.34)(	149.85)(	191.51)(	394.42)
ROUTED TO	DAM-2	2.49	1	1011.	1523.	2066.	2774.	3586.	4352.	5097.	6484.	13539.
		(6.45)		(28.63)(	43.13)(	58.51)(	78.55)(	101.54)(	123.25)(	144.32)(	183.61)(	383.38)

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	97.65	97.65	101.65
STORAGE	0.	0.	62.
OUTFLOW	0.	0.	1584.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	100.16	0.00	34.	800.	0.00	40.33	0.00
.15	100.97	0.00	49.	1209.	0.00	40.33	0.00
.20	101.72	.07	63.	1638.	.33	40.33	0.00
.25	102.26	.61	74.	2336.	.67	40.17	0.00
.30	102.63	.98	82.	2965.	1.00	40.17	0.00
.35	102.93	1.28	88.	3533.	1.17	40.17	0.00
.40	103.19	1.54	93.	4074.	1.50	40.17	0.00
.50	103.65	2.00	103.	5121.	2.50	40.17	0.00
1.00	105.58	3.93	145.	10500.	5.50	40.00	0.00

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	92.65	92.65	94.60
STORAGE	45.	45.	69.
OUTFLOW	0.	0.	1280.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	94.30	0.00	65.	1011.	0.00	40.17	0.00
.15	94.82	.22	73.	1523.	1.00	40.17	0.00
.20	95.27	.67	80.	2066.	1.67	40.17	0.00
.25	95.79	1.19	88.	2774.	2.00	40.17	0.00
.30	96.28	1.68	97.	3586.	3.00	40.17	0.00
.35	96.70	2.10	104.	4352.	4.00	40.17	0.00
.40	97.05	2.45	111.	5097.	4.67	40.17	0.00
.50	97.67	3.07	124.	6484.	5.33	40.17	0.00
1.00	100.17	5.57	185.	13539.	6.50	40.00	0.00

Sh 18

APPENDIX

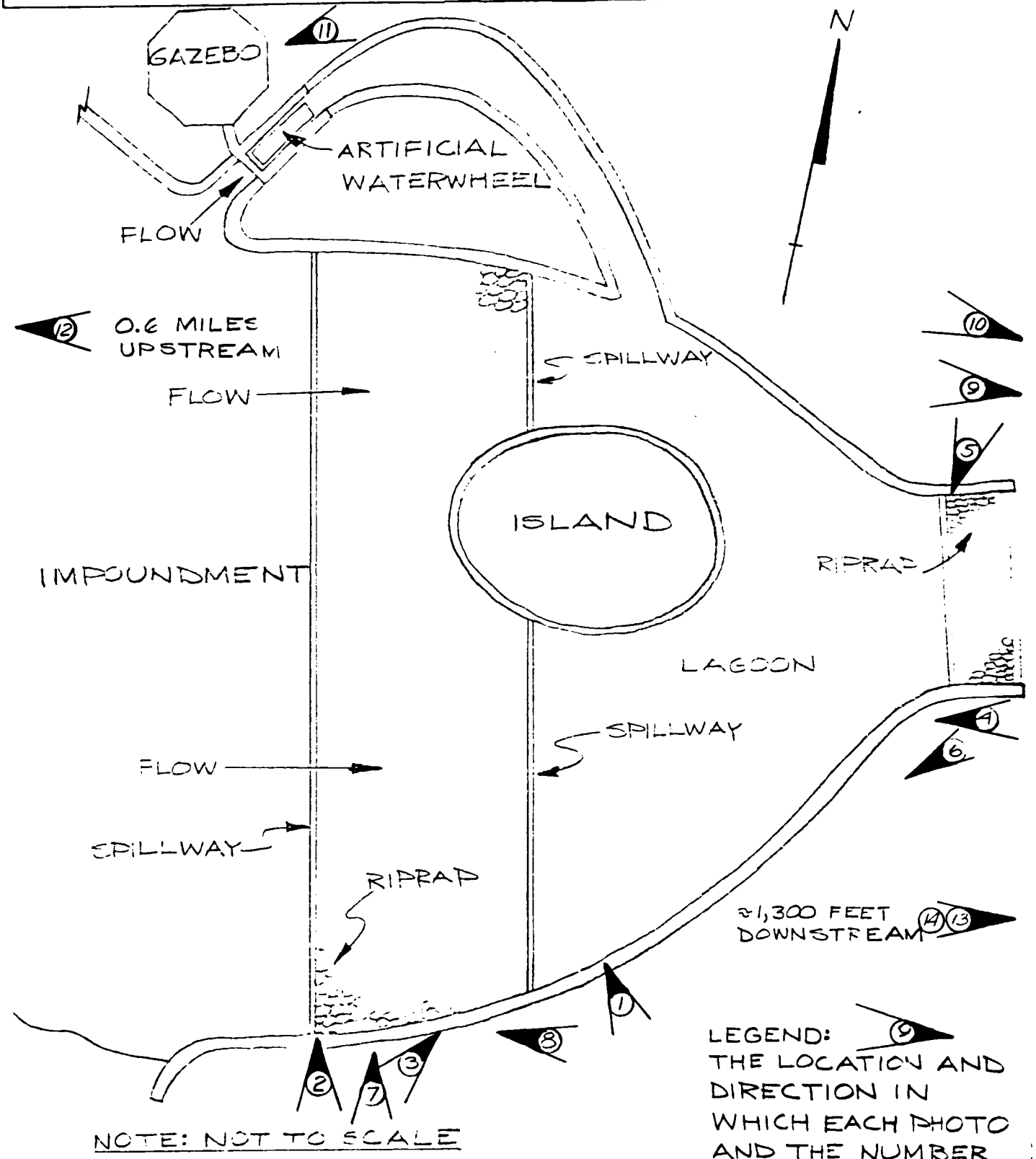
D

Photographs

APPENDIX D
SELECTED PHOTOGRAPHS OF THE SITE

O'BRIEN & GERE
ENGINEERS INC

ECHO LAKE DAM	SHEET 4	FILE	DATE 6/24/81	JOB NO. 1800.006.113



NOTE: NOT TO SCALE

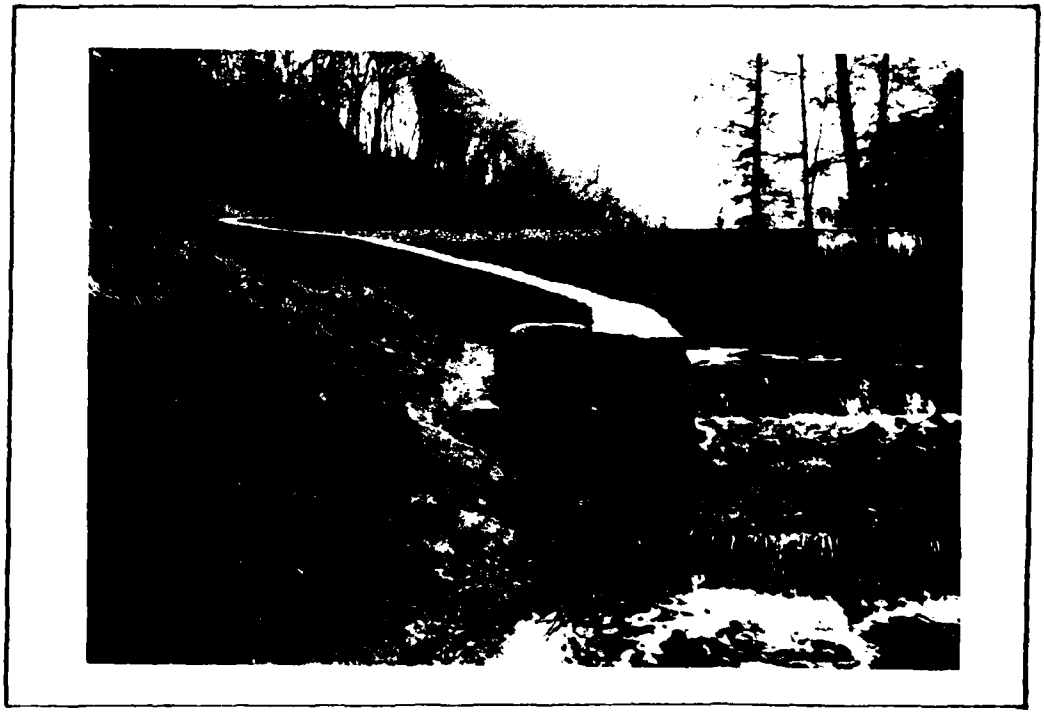
1. OVERVIEW OF IMPOUNDMENT, DAM AND THE AREA IMMEDIATELY DOWNSTREAM OF THE DAM. (4/24/81)

2. VIEW FROM THE RIGHT SIDE OF THE DAM SHOWING DISCHARGE CONCENTRATION OF LEFT SIDE OF SPILLWAY. (4/24/81)

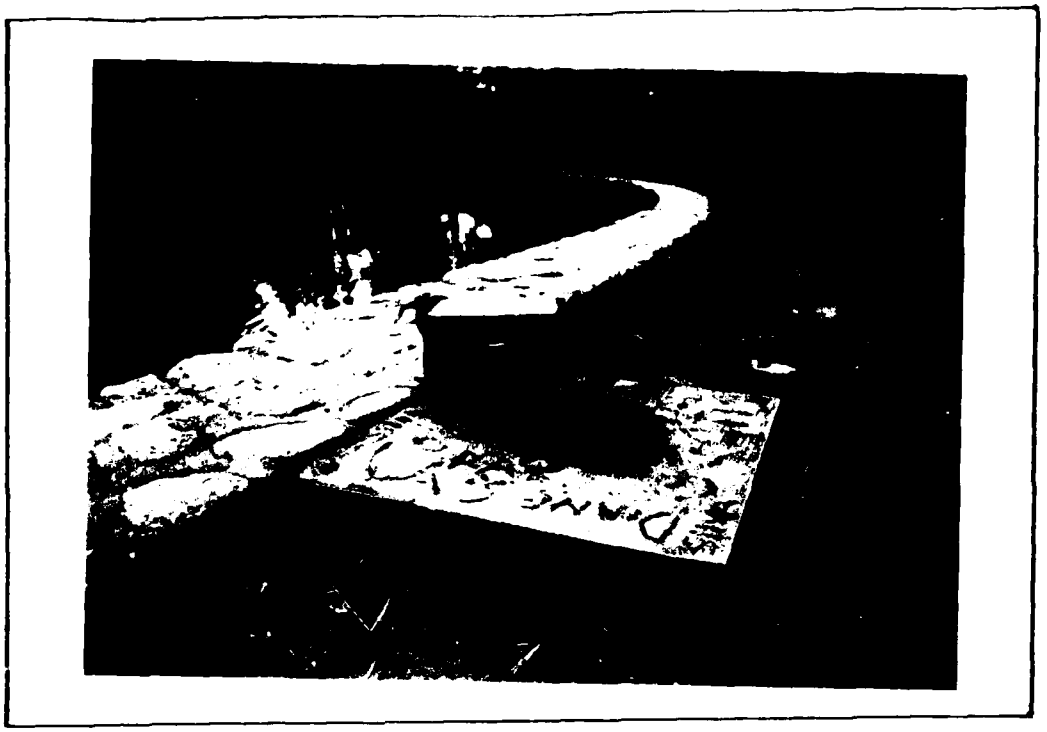
3. VIEW FROM THE CREST OF THE DAM LOOKING DOWNSTREAM. (4/24/81)

4. STEPPED CHANNEL DOWNSTREAM OF THE DAM. (4/24/81)

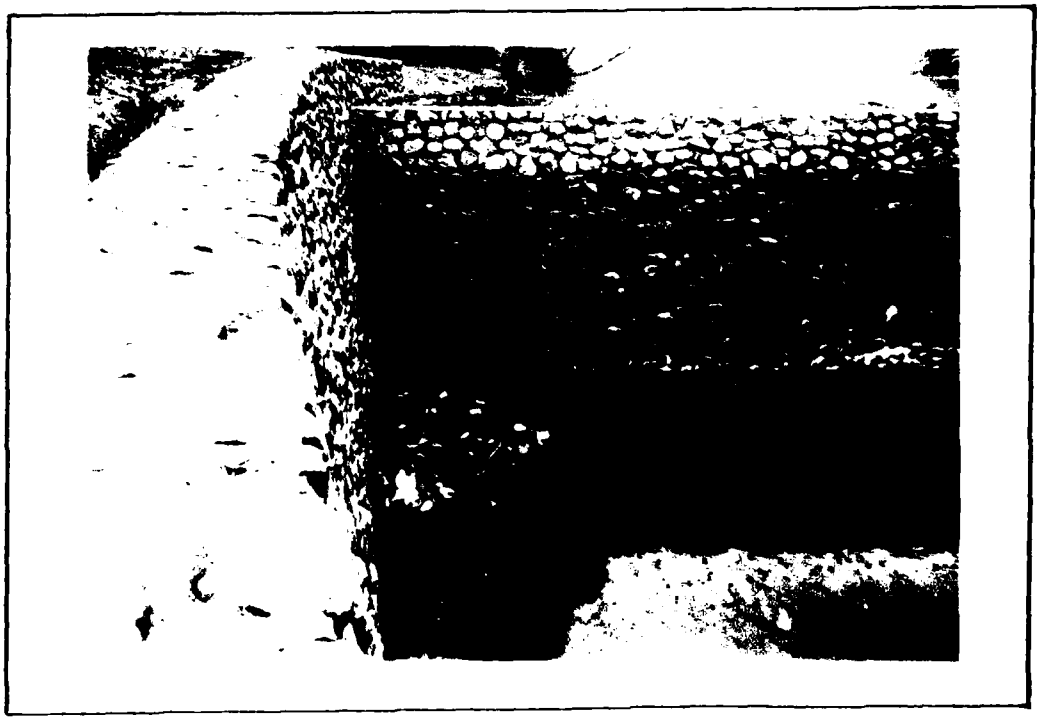
5. CHANNEL AND BANK CONDITIONS APPROXIMATELY 100 FEET DOWNSTREAM OF THE DAM. (4/24/81)



6. CHANNEL AND BANK CONDITIONS ON THE RIGHT SIDE AT THE DOWNSTREAM END OF THE STEP CHANNEL SPILLWAY. (4/24/81)



7. ACCESS TO THE RESERVOIR DRAIN PIPE VALVE ON THE RIGHT SIDE OF THE DAM. (4/24/81)

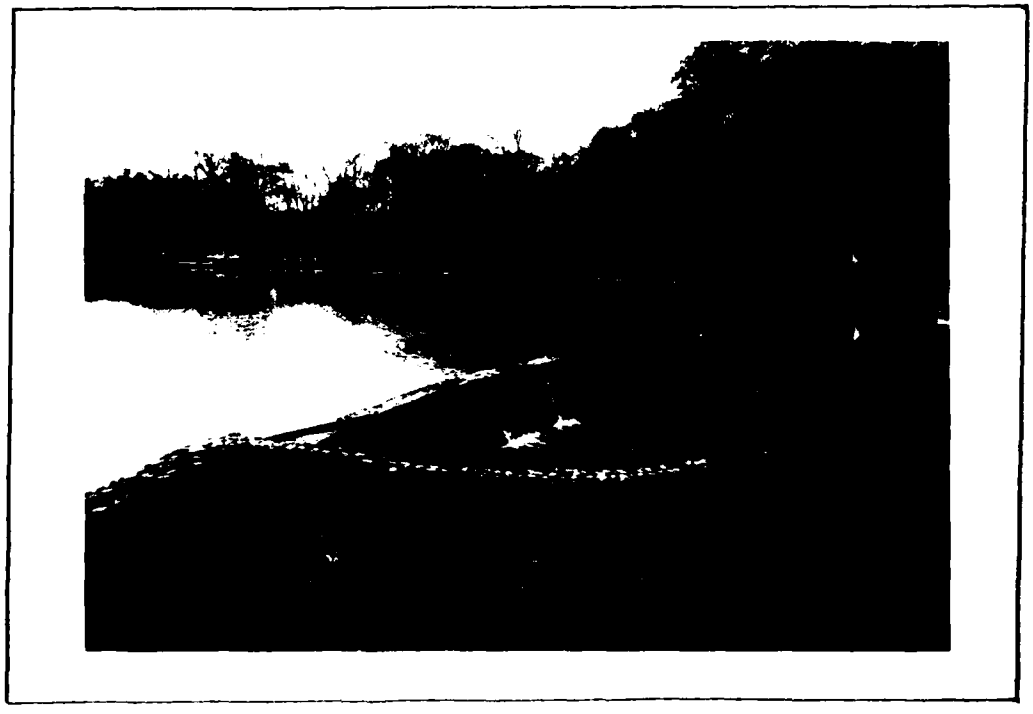


8. OUTLET OF THE RESERVOIR DRAIN PIPE ON THE RIGHT SIDE OF THE DAM. (4/24/81)

9. CHANNEL AND BANK CONDITIONS IMMEDIATELY DOWNSTREAM OF STEPPED CHANNEL. (4/24/81)

10. TYPICAL DOWNSTREAM CHANNEL CONDITIONS. (4/24/81)

11. DECORATIVE WATERWHEEL AND SHELTER AT THE LEFT ABUTMENT OF THE DAM. (4/24/81)



12. SPILLWAY FOR IMPOUNDMENT WHICH DISCHARGES DIRECTLY INTO ECHO LAKE ABOUT 0.6 MILES UPSTREAM OF ECHO LAKE DAM. (4/24/81)

13. POTENTIAL DAMAGE AREA LEFT OF THE CHANNEL ABOUT 0.25 MILES DOWNSTREAM OF ECHO LAKE DAM. (4/24/81)

14. POTENTIAL DAMAGE AREA RIGHT OF THE CHANNEL ABOUT 0.25 MILES DOWNSTREAM OF ECHO LAKE DAM. (4/24/81)

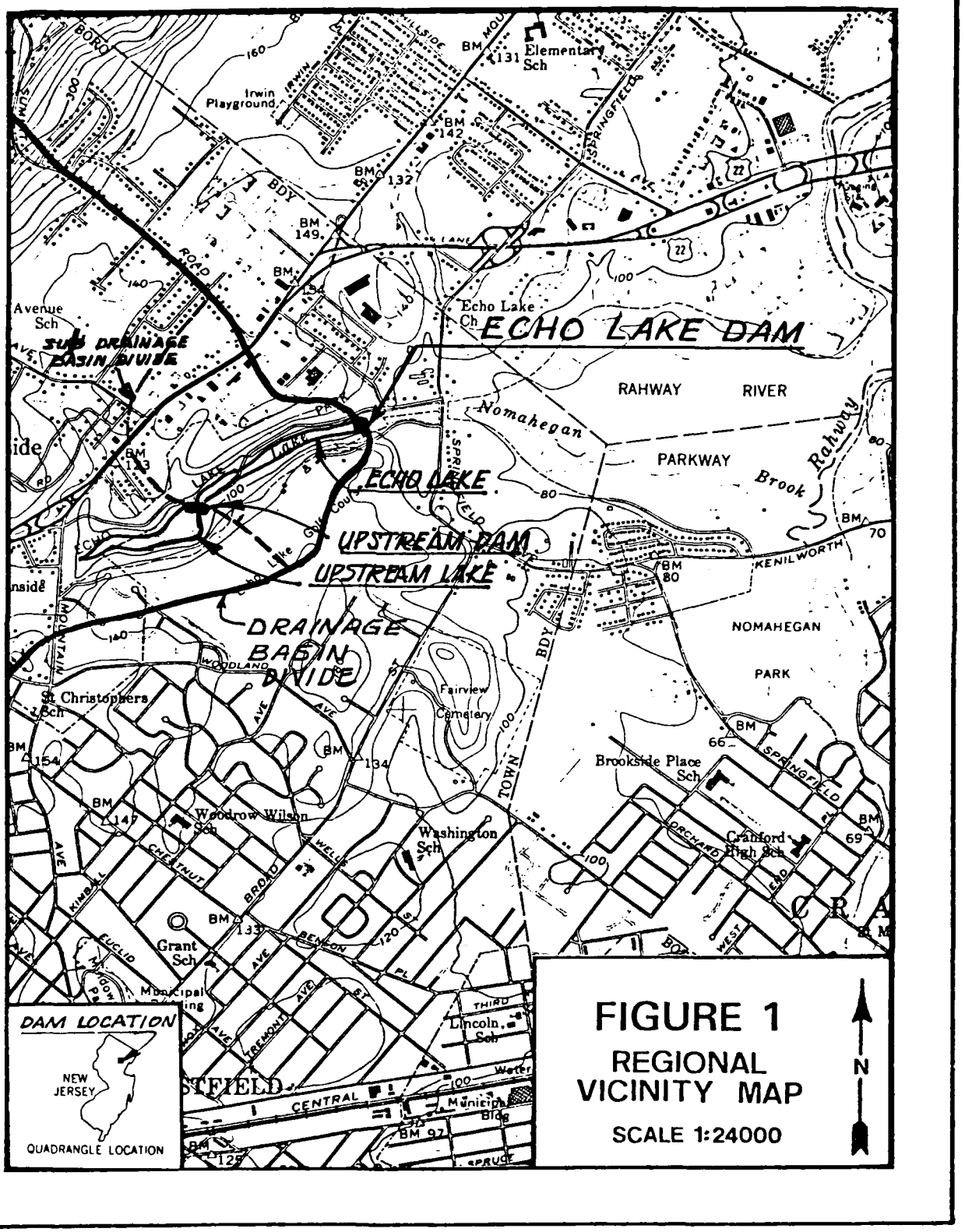
APPENDIX

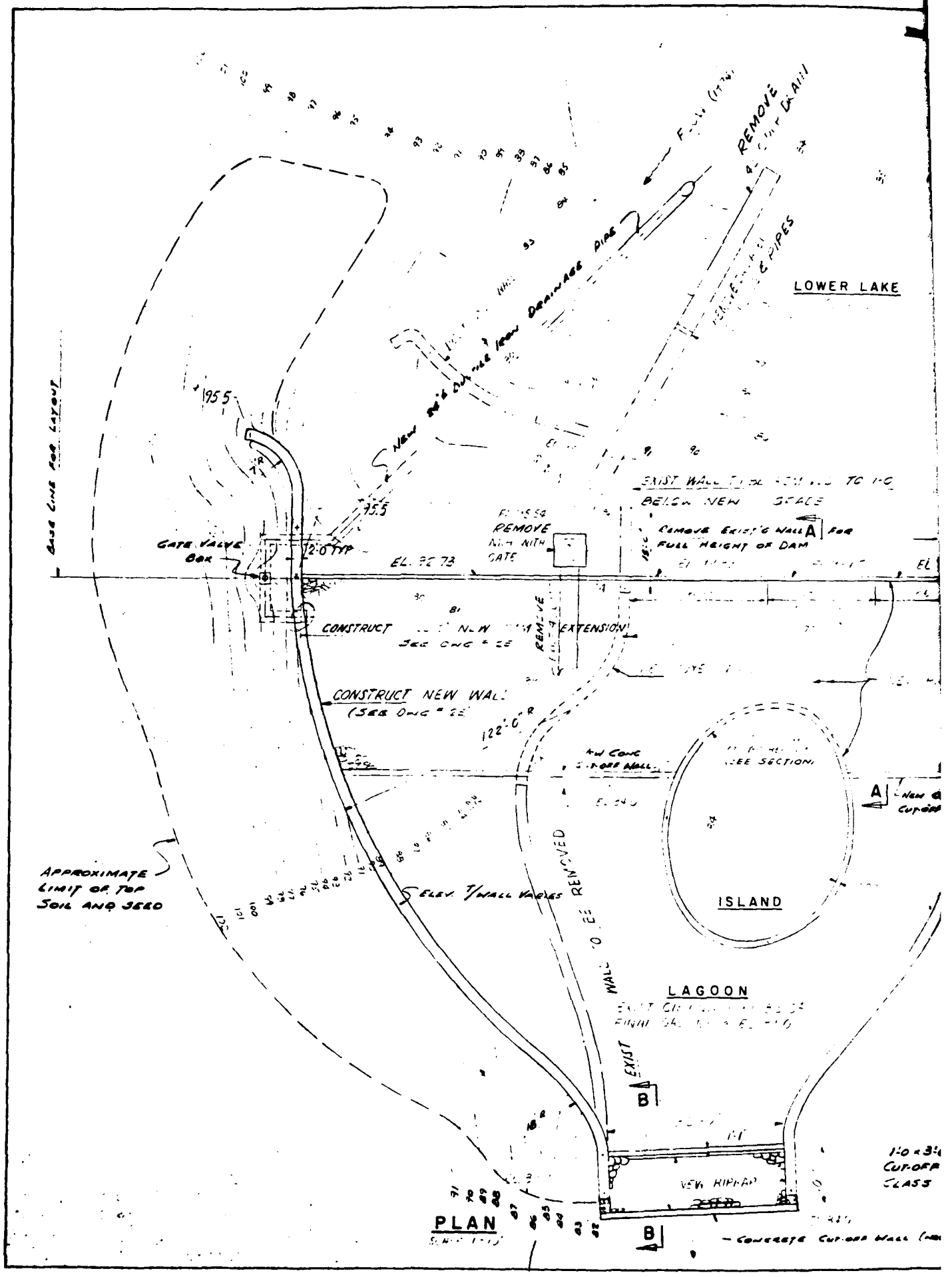
E

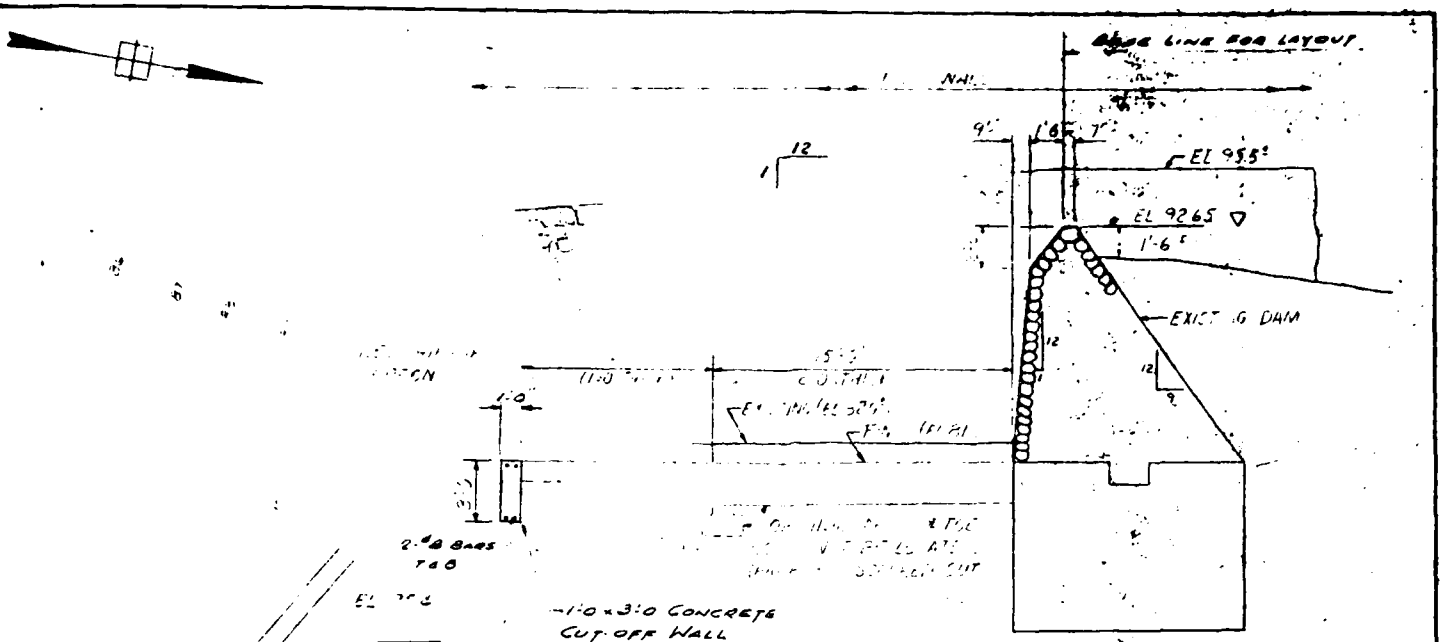
Drawings

ECHO LAKE DAM
APPENDIX E
DRAWINGS

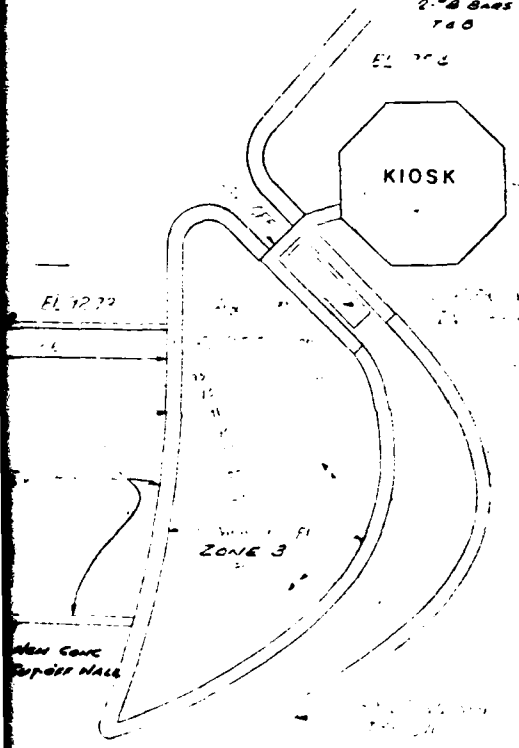
TABLE OF CONTENTS

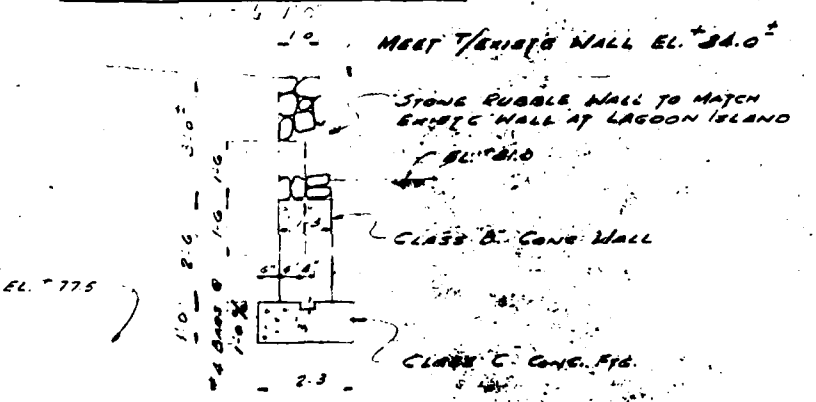

ECHO LAKE DAM
SUB DRAINAGE BASIN DIVIDE
ECHO LAKE
UPSTREAM DAM
UPSTREAM LAKE
DRAINAGE BASIN DIVIDE
RAHWAY RIVER
Nomahegan PARKWAY
Rahway Brook
NOMAHEGAN PARK
Echo Lake Ch
Irwin Playground
Elementary Sch
Avenue Sch
St Christophers Sch
Fairview Cemetery
Brookside Place Sch
Woodrow Wilson Sch
Washington Sch
Grant Sch
Lincoln Sch
Cranford High Sch
Municipal Bldg
Municipal Parking
DAM LOCATION
NEW JERSEY
QUADRANGLE LOCATION
FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24000
N


LOWER LAKE
ISLAND
LAGOON
REMOVE
GATE VALVE BOX
REMOVE WITH GATE
CONSTRUCT NEW WALL
(SEE ONG # 22
APPROXIMATE LIMIT OF TOP SOIL AND SEED
EXIST
NEW RIPRAP
PLAN
EL. 95.73
12'-0" TYP
122'-0" R
A
B



SECTION A-A (MAIN DAM)



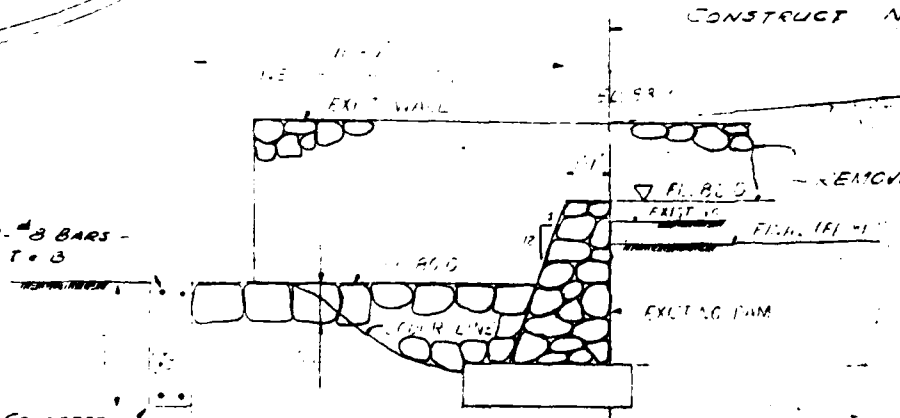


SECTION THRU WALL AT LAGOON ISLAND

SCALE 3/4"=1'-0

CONSTRUCT NEW WALL

SHEET 2

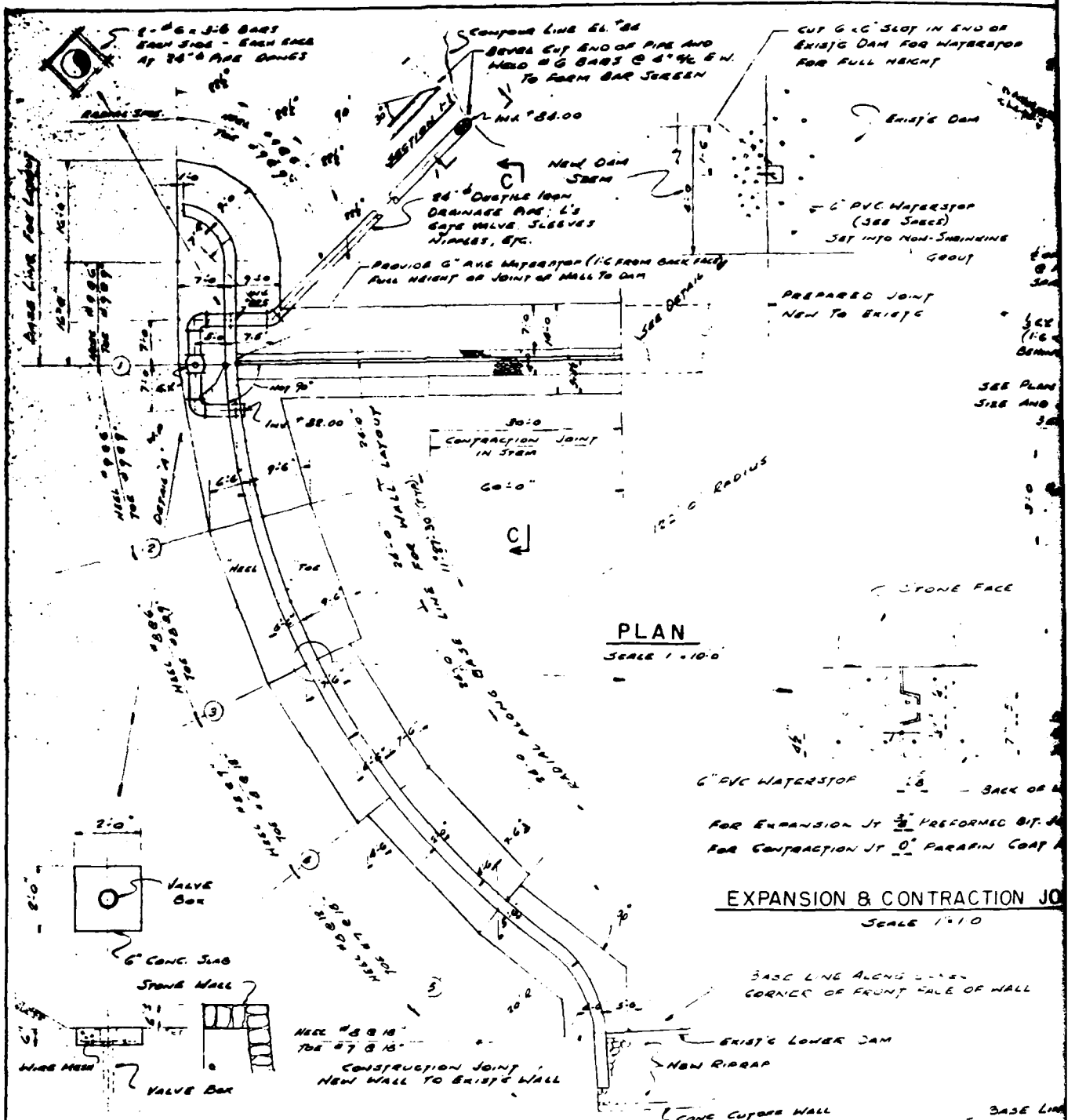


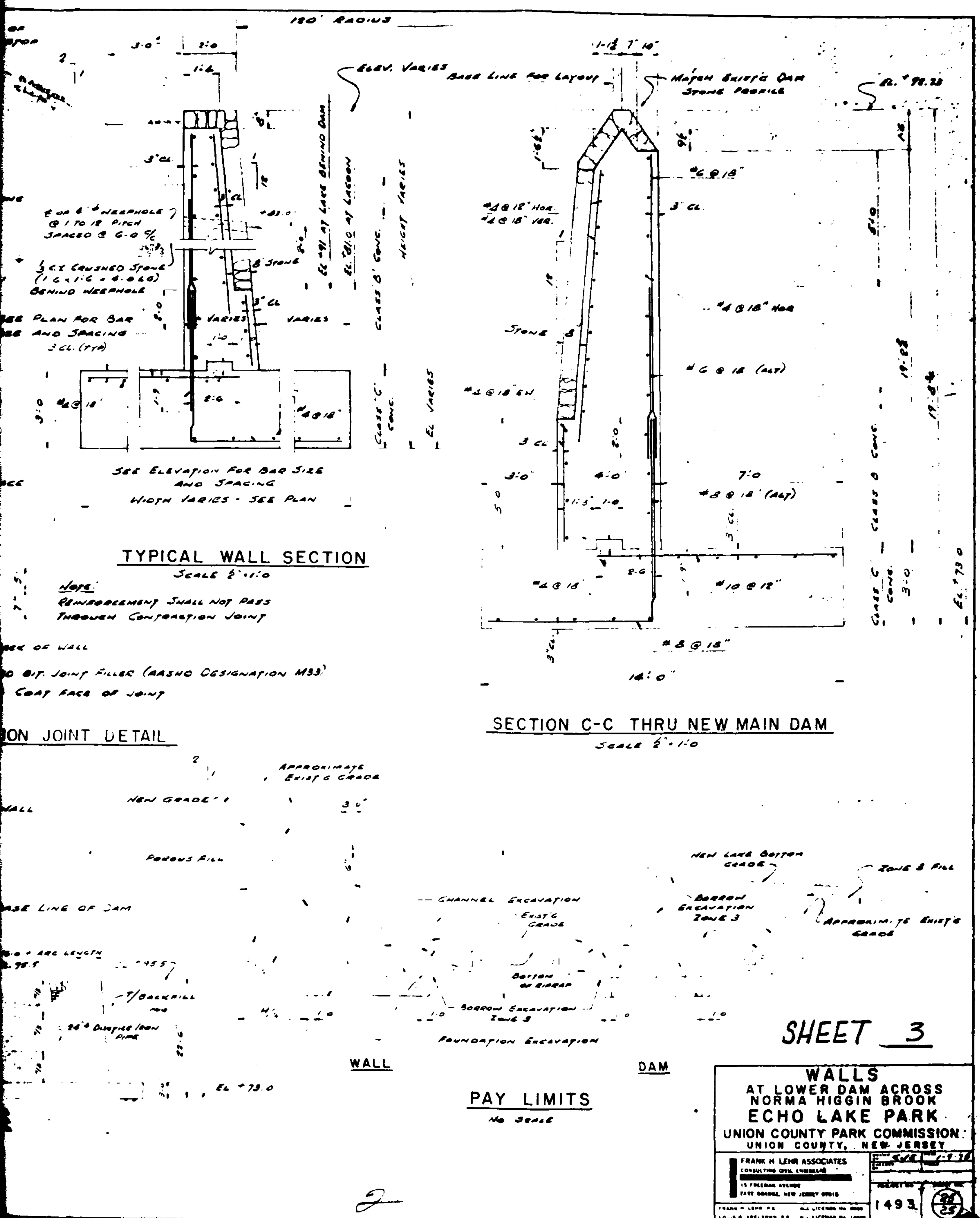
SECTION B-B (SMALL DAM)

NOTES
1. EXIST'G CONTOURS ARE DASHED
2. PROPOSED CONTOURS ARE SOLID

GENERAL PLAN & WALLS
AT LOWER DAM ACROSS NORMA HIGGIN BROOK
ECHO LAKE PARK
UNION COUNTY PARK COMMISSION
UNION COUNTY, NEW JERSEY

1493
24/25


PLAN
SCALE 1"=10'-0"
EXPANSION & CONTRACTION JO
SCALE 1"=1'-0
DETAIL A-VALVE BOX COVER
SCALE 6"=1'-0
DEVELOPED FRONT ELEVATION OF RETAINING WALL
SCALE 1"=10'-0
Valve Box
6" Conc. Slab
Stone Wall
Wire Mesh
Valve Box
Construction Joint
New Wall To Exist'g Wall
Exist'g Lower Dam
New Riprap
Conc Cutoff Wall
Contraction Joint
Expansion Joint
Exist'g Dam
New Dam Stem
Stone Face
Back Face
Face of Dam
Riprap
Weep Holes
Vertical Reinforcement - Back Face of Wall

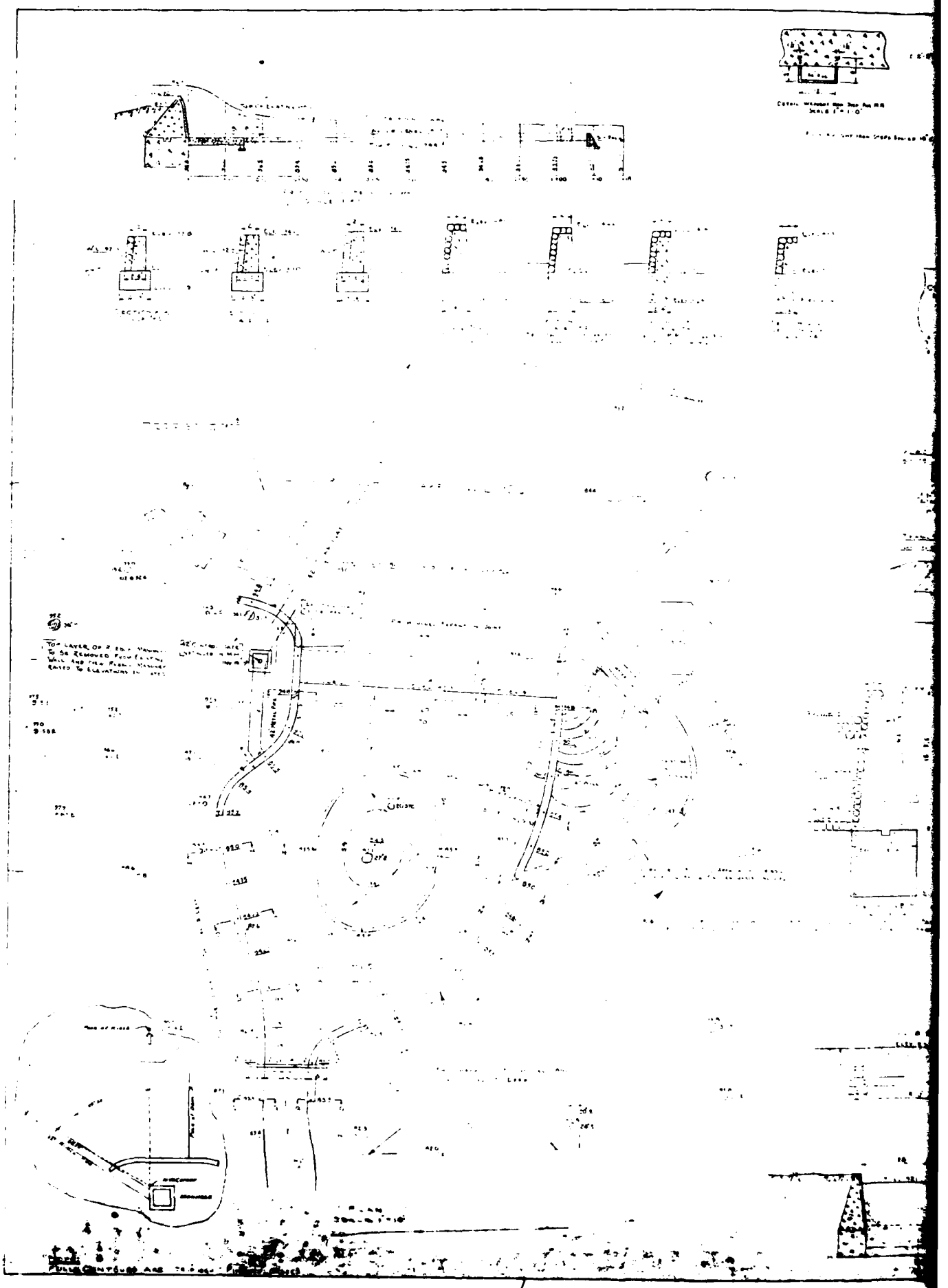


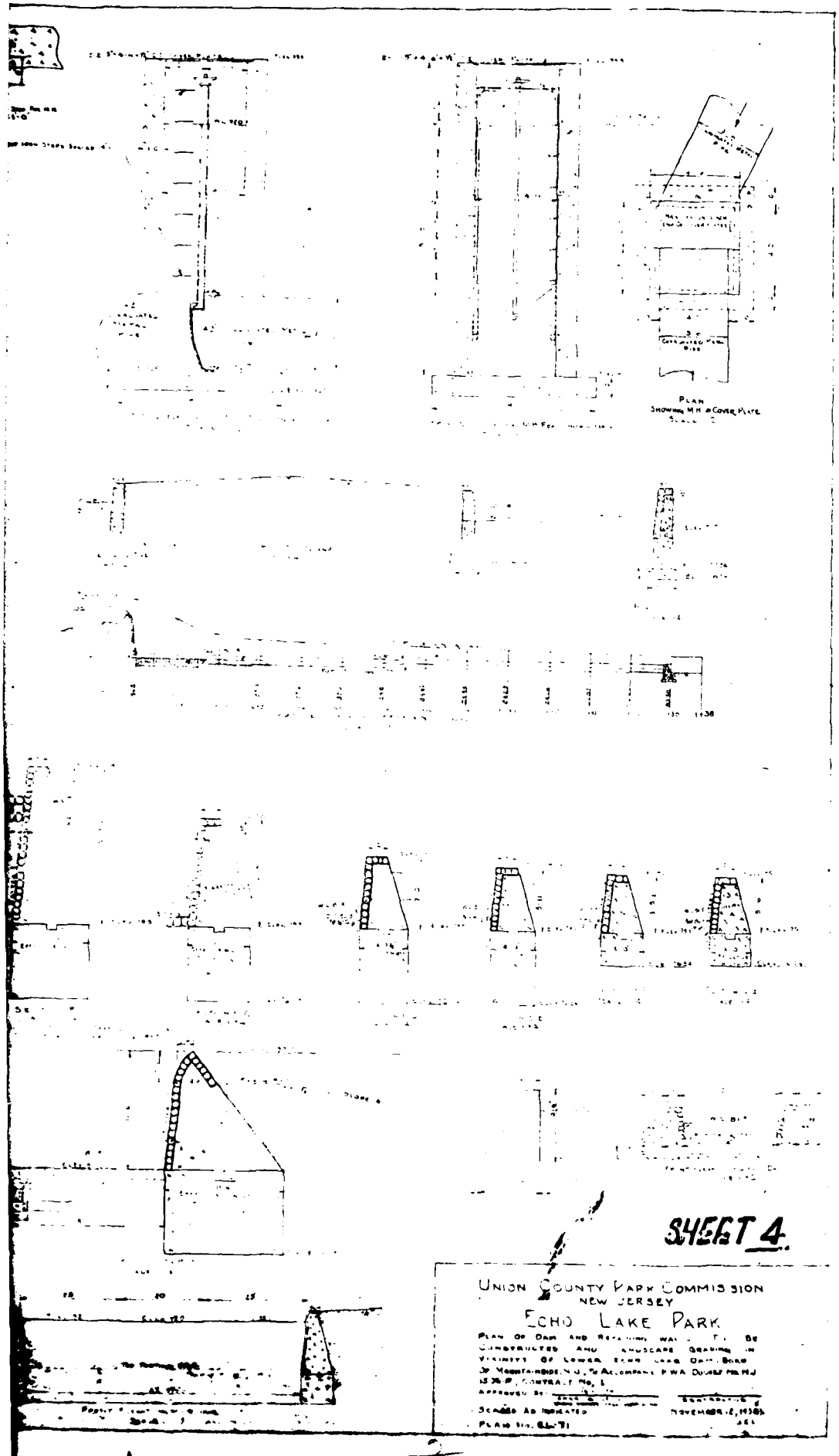
SHEET 3

WALLS
AT LOWER DAM ACROSS NORMA HIGGIN BROOK
ECHO LAKE PARK
UNION COUNTY PARK COMMISSION
UNION COUNTY, NEW JERSEY

FRANK H LEHR ASSOCIATES
CONSULTING CIVIL ENGINEERS
[redacted]
EAST ORANGE, NEW JERSEY

1493





SHEET 4.

UNION COUNTY PARK COMMISSION
NEW JERSEY

ECHO LAKE PARK

PLAN OF DAM AND RETAINING WALL TO BE CONSTRUCTED AND LANDSCAPE GRADING IN VICINITY OF LOWER ECHO LAKE. UNION COUNTY BOARD OF FREEHOLDERS, N.J., TO ACCOMPANY P.W.A. DOCKET NO. NJ 1535-F, CONTRACT No. 1

APPROVED BY: _____ _____

SCALES AS INDICATED — NOVEMBER 6, 1936

PLAN No. EL-71

APPENDIX

F

Site Geology

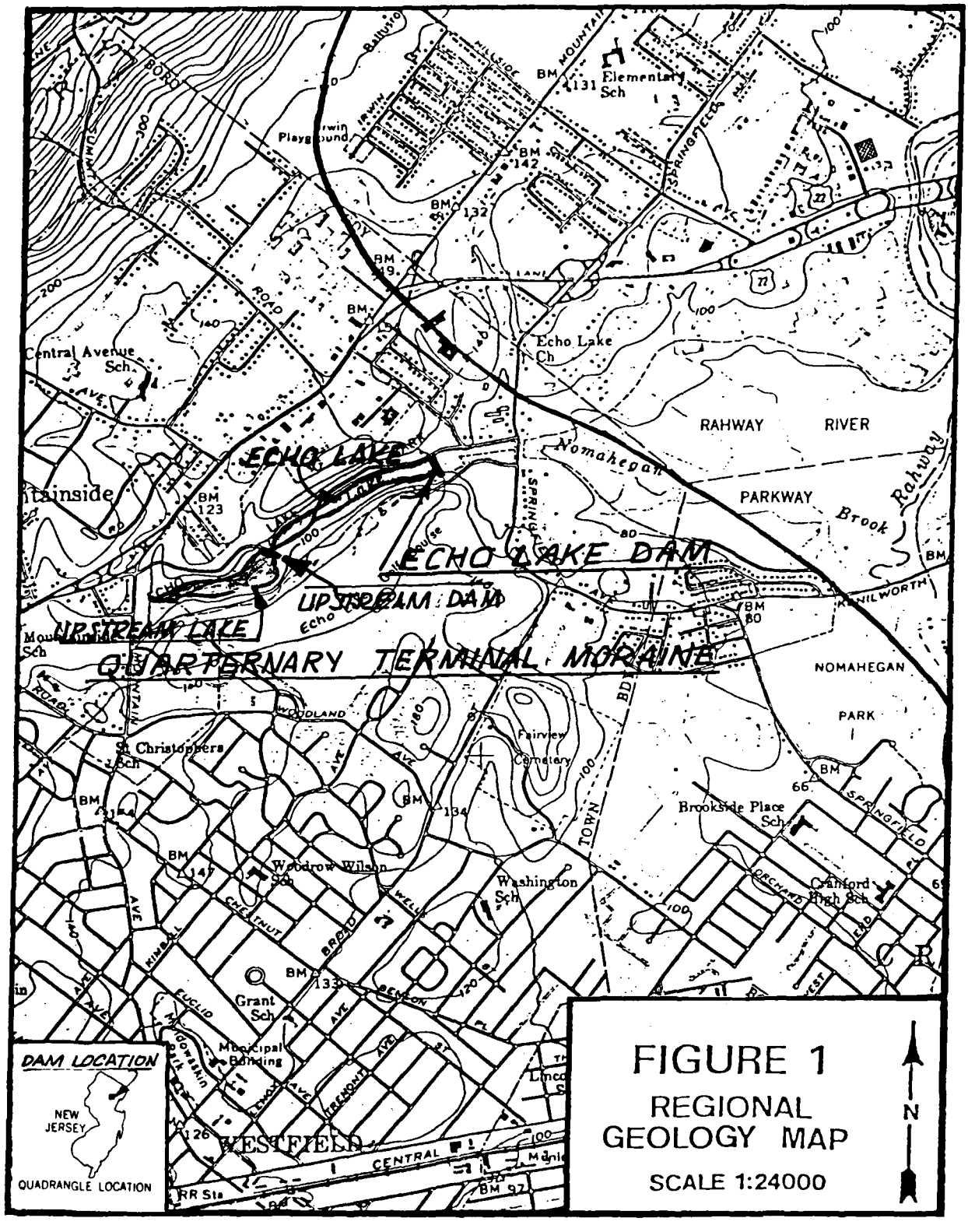
SITE GEOLOGY

ECHO LAKE DAM

Echo Lake Dam is located in Union County within the Triassic Lowland portion of the Piedmont physiographic province. The site of the dam and lake is underlain by Triassic age sedimentary rock units of the Brunswick formation, a series of brown to red siltstones and sandstones which strike predominantly NE-SW and dip about 10^{o} to 20^{o} NW. Although no major faults are known to occur near the site, the existence of minor offsets are possible in the Brunswick units. Fracturing and jointing occur throughout the formation.

Overburden consists of residual soils (5'+) and remnant pockets of Wisconsin glacial epoch recessional moraine materials may mantle valley bottoms and hillside areas. Thickness and character of these glacially-derived materials will vary appreciably.

Some swampy conditions may occur within the recessional moraine areas in low-lying areas.


ECHO LAKE
ECHO LAKE DAM
UPSTREAM DAM
UPSTREAM LAKE
QUARTERNARY TERMINAL MORAINE
RAHWAY RIVER
Nomahegan Brook
Rahway
PARKWAY
Echo Lake Ch
Central Avenue Sch.
Mountainside Sch
St Christophers Sch
Woodrow Wilson Sch
Washington Sch
Grant Sch
Municipal Building
Brookside Place Sch
Crawford High Sch
Fairview Cemetery
NOMAHEGAN PARK
WESTFIELD
DAM LOCATION
NEW JERSEY
QUADRANGLE LOCATION
FIGURE 1
REGIONAL GEOLOGY MAP
SCALE 1:24000
N

APPENDIX G

STRUCTURAL STABILITY

ECHO LAKE DAM
APPENDIX G
STRUCTURAL STABILITY DATA

TABLE OF CONTENTS

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM	1	REH	5/15/81	1800-006-113
		VB	6/5/81	

STABILITY ANALYSES

ASSUMPTIONS

Concrete Density	–	140 pcf
Silt Density	–	60 pcf (submerged)
At Rest Earth Coeff	–	0.5
Shear Stress	–	50
Coeff of Friction	–	0.4

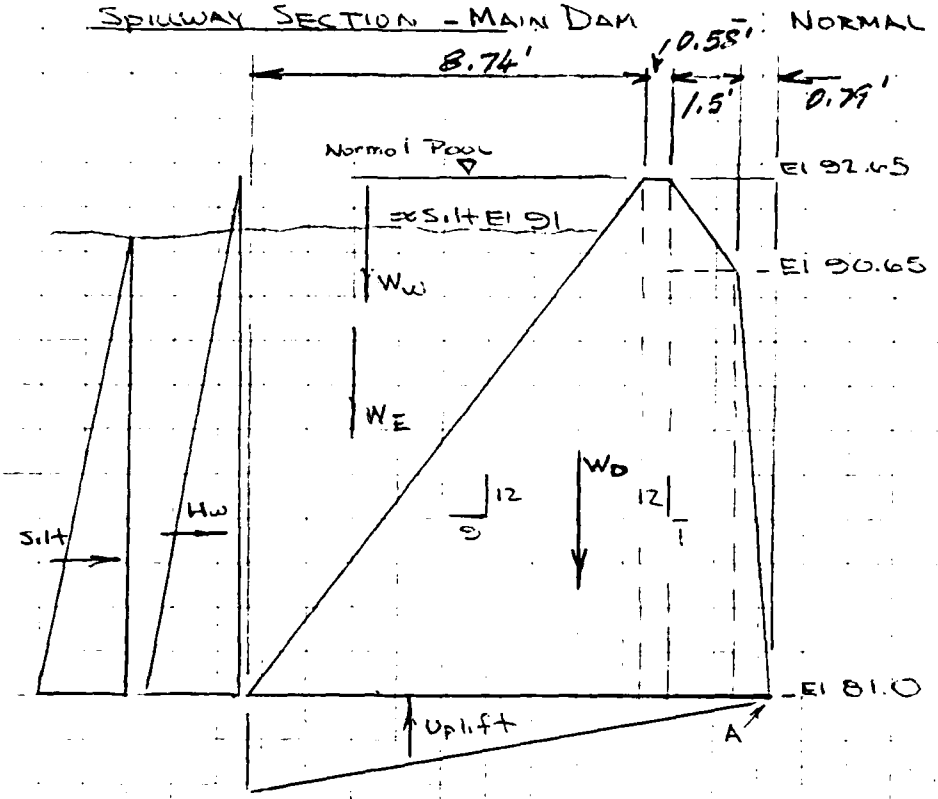
O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM	2	REH	5/15/81	1E00-006-113

✓RB 6/5/81

Existing Dam Since 1938

SPILLWAY SECTION - MAIN DAM



$$\frac{\Sigma M_A^{\circlearrowleft}}{A} = \frac{\frac{1}{2}(9.65).8(.53) + 1.5(9.65)(1.55) + \frac{1}{2}(1.5)2(1.8) + (.58)(11.65)2.59 + \frac{1}{2}(11.65)8.73(5.79)}{3.86 + 14.48 + 1.5 + 6.76 + 50.8}$$

$$= \frac{339.11}{77.40} = 4.38'$$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM	3	REH	5/15/81	1600-006-113

✓ 6/5/81

Normal Pool Loading

Force	kips	Arm (feet)	Moment (ft.kips)
Dam Wt -	$77.40(.140) = 10.84 \downarrow$	4.38	+ 47.5
Wwater -	$\frac{1}{2}(11.65)8.73(.062) = 3.15 \downarrow$	8.7	+ 27.4
Wearth (Sediment) -	$\frac{1}{2}(10)(7.5)(.060) = 2.25 \downarrow$	9.11	+ 20.5
Hw -	$\frac{1}{2}(.062)11.65^2 = 4.21 \rightarrow$	3.88	- 16.3
Silt -	$\frac{1}{2}(.5)(.060)10^2 = 1.50 \rightarrow$	3.33	- 5.0
Uplift -	$\frac{1}{2}(11.65)(.062)11.62 = 4.2 \uparrow$	7.75	- 32.6

Resultant Location and Eccentricity

$\Sigma M/\Sigma F_v = \frac{41.5}{12.04} = 3.45' < 3.87'$ - Resultant is located approx 0.4 feet outside middle third of base width

$e = \frac{11.61}{2} - 3.45 = 2.36'$

Foundation Stresses

$p = \frac{\Sigma V}{B}\left(1 \pm \frac{6e}{B}\right) = \frac{12.04}{11.62}\left(1 \pm \frac{14.61}{11.62}\right) = 1.04(1 \pm 1.26)$

$= 7.2(1 \pm 1.26) = + 16.3$ psi $(+2.35$ K/F/2$)$

$- 1.9$ psi $(-0.27$ K/F/2$)$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM	4	REH	5/18/81	1E[illegible]-113
	✓		6/5/81	

Shear

$$S.F. = \frac{\Sigma V_F (.4) + 7.2(11.62)}{\Sigma H_F} = \frac{12(.4) + 7.2(11.62)}{5.71}$$

$$= \frac{4.8 + 83.6}{5.71} = 15.5$$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam	4A	REH	6/24/81	1800-006-113

VEC 6/24/81

Earthquake Loading Condition (Horizontal)

Center of Gravity (vertical)

$$= \frac{\frac{1}{2}(.79)9.65\left(\frac{9.65}{3}\right) + \frac{1}{2}(2)(1.5)(10.3) + 9.65(1.5)\frac{9.65}{2} + .58(11.65)\frac{11.65}{2} + \frac{1}{2}(11.65)8.74\frac{11.65}{2}}{\frac{1}{2}(.79)(9.65) + \frac{1}{2}(2)(1.5) + 9.65(1.5) + .58(11.65) + \frac{1}{2}(11.65)(8.74)}$$

$$= \frac{334.61}{77.46} = 4.3 \text{ feet}$$

Acceleration due to earthquake, Zone 1 $a = .025g$

Force	Kips	Arm (ft)	Moment (ft·kips)
Dam →	(.025)10.84 = .271	4.3	1.16

Water → (Refer to "Design of Small Dams" page 335)

$Pe = C\lambda\gamma h = .4(.025)(.062)11.65 = .0072$ K/SF

$Ve = 0.726(.0072)11.65 = .06$ kips

$Me = 0.299(.0072)(11.65)^2 = .29$ Ft·Kips

Total negative loading due to Earthquake = -.27 + -.06
= -.33 Kips

Total negative Moment due to Earthquake = -1.45 ft kips

The effects of earthquake loadings on the dam are not significantly different from normal pool loadings

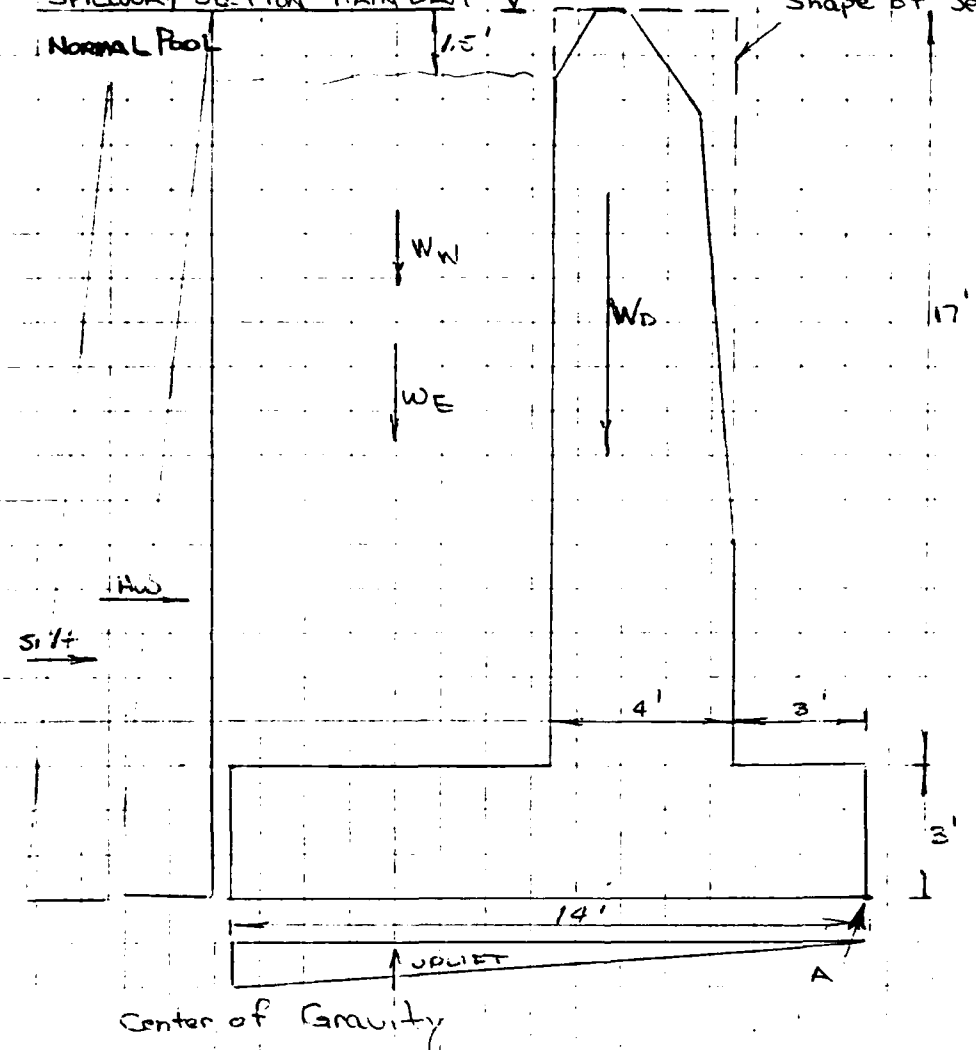
Structure meets current stability criteria for earthquake loading for analyses performed herein.

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM	5	REH	5/15/81	18000.006-113

Built 1975 JL 6/5/81

SPILLWAY SECTION - MAIN DAM



$$\frac{\Sigma M_A^{\circlearrowleft +}}{A} = \frac{14(3)7 + 17(4)5}{14(3) + 17(4)} = \frac{634}{110} = 5.76'$$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
ECHO LAKE DAM	6	RFH	5/15/81	18200.006-113

VCH 6/5/81

NORMAL POOL LOADING

FORCE	kips	Arm (feet)	Moment (ft kips)
Dam Wt	− 110(.14) = 15.4 ↓	5.76'	+ 88.7
Wwater	− 17(7)(.062) = 7.38 ↓	10.5	+ 77.5
WEARTH	− 15.5(7)(.060) = 16.51 ↓	10.5	+ 68.4
Hw	− ½(.062)(20²) = 12.4 →	6.7	− 83.1
Silt	− ½(.5)(.060)(18.5²) = 5.1 →	6.2	− 31.6
Uplift	− ½(.062)20(14) = 8.7 ↑	9.3	− 80.9

Resultant Location and Eccentricity

$$\Sigma M / \Sigma F_V = 39 / 20.6 = 1.89'$$

- Resultant is located approx 4.4 feet outside middle third of base width

$$e = \frac{14}{2} - 1.9 = 5.1'$$

Foundation Stresses

$$p = \frac{\Sigma V}{B}\left(1 \pm \frac{6e}{B}\right) = \frac{20.6}{14}\left(1 \pm \frac{30.6}{14}\right) = 1.47 \pm (1 \pm 2.19)$$

$$= 10.2(1 \pm 2.19) = 32.5 \text{ psi } (+4.68^K/F^2)$$
$$- 12.1 \text{ psi } (-1.74^K/F^2)$$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam	7	REH	5/18/81	1800.006.113

✓ 6/5/81

Shear

$$S.F = \frac{20.6(.4) + 7.2(14)}{17.5} = \frac{109.0}{17.5} = 6.2$$

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam	7A	REH	6/24/81	1800-006-113

✓ 6/24/81

Earthquake Loading Condition (Horizontal)

Center of Gravity (Vertical)

$$= \frac{14(3)1.5 + 17(4)(3+\frac{17}{2})}{14(3) + 17(4)}$$

$$= \frac{63 + 782}{42 + 68} = \frac{845}{110} = 7.68'$$

Acceleration due to earthquake, Zone 1 $\alpha = .025g$

Force	Kips	Arm (ft)	Moment (ft kips)
Dam →	.025(15.4) = .385	7.68	-2.96

Water → (Refer to "Design of Small Dam's page 335)

$$Pe = C\lambda\gamma h = .73(025)(.062)20 = .0226 \text{ k/SF}$$

$$Ve = 0.726(.0226)(.20) = .33 \text{ kips}$$
$$Me = .299(.0226)(20^2) = -2.7 \text{ ft·kips}$$

Total negative loading due to earthquake = -.72 kips

Total negative moment due to earthquake = -5.66 k·p·ft

O'BRIEN & GERE

SUBJECT	SHEET	BY	DATE	JOB NO
Echo Lake Dam	7B	REH	6/24/81	1800-006-113

VBK 6/24/81

Resultant Location and Eccentricity

$\Sigma M / \Sigma F_r = 39 - 5.66 / 2016 = 1.62'$ Resultant is located approximately 3 feet outside middle third of base width

$e = 14/2 - 1.6 = 5.4$

Foundation Stresses

$$p = V/B\left(1 \pm \frac{6e}{B}\right) = \frac{20.6}{14}\left(1 \pm \frac{32.4}{14}\right)$$

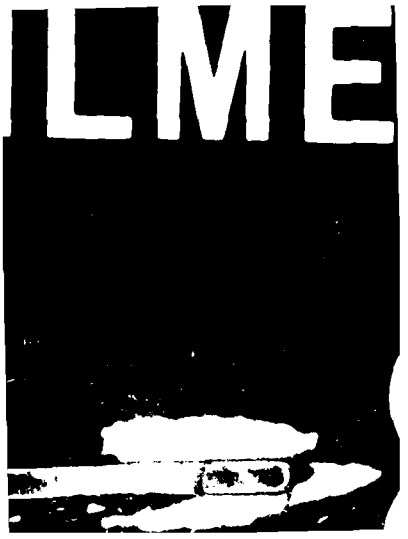
$$= 1.47\,(1 \pm 2.31)$$

$$= +337 \text{ psi } (4.86 \text{ k/sf})$$
$$-13.4 \text{ psi } (-1.93 \text{ k/sf})$$

Sliding (Shear)

$$SF = \frac{20.6(.4) + 7.2(14)}{17.5 + .72} = 5.98$$

Structure meets current stability criteria for earthquake loading for analyses performed herein.


LME